
C. Frusher Howard

# HOWARD'S

# CALIFORNIA CALCULATOR,

THE

Newest, Quickest and most Complete
Instructor for all who
desire to be

*"QUICK AT FIGURES."*

THE

## BUSINESS MAN'S FAITHFUL ASSISTANT,

THE

School Boy's Companion and Friend.

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ADDRESS ALL ORDERS FOR THIS BOOK TO THE AUTHOR ONLY,

C. FRUSHER HOWARD,

SAN FRANCISCO.
1877.

# PREFACE.

THE ability to make business calculations with ease, accuracy and rapidity, is an all-important acquisition to every class of the community. The whole system of numerical science has hitherto been so abstruse and difficult as to deter all, but a small per centage, from giving the weary months and years of time, labor and study necessary to master its mysteries. WONDERFUL and STARTLING discoveries have RECENTLY been made and embodied in the following rules, simplifying and shortening all the operations of numbers, so as to make RAPID CALCULATION easy to all; so *easy*, that a person of average capacity can learn any rule in a few minutes, and so *rapid* in execution, that what before was the work of *hours*, becomes the work of *seconds.*

In actual business, the smart, practical men, *the men who make fortunes*, rarely use the methods of calculating taught in the schools; the value of time compels them to substitute *easy* and *rapid* rules for the *clumsy*, *cumbrous* and *tedious* processes found in the books.

All the shortest methods known, are here brought together and explained in such a manner that any child capable of learning the multiplication table, can,—without any other instructor—learn any rule in this book in a very short time.

The Teacher, the Banker, the Merchant, the Professional man the Mechanic, the Farmer, the Clerk, and the Laborer, will here find the *best*, *easiest to learn*, and most *rapid* rules for making the calculations incident to their several callings.

The Author has studied to make the book completely fill the place of a teacher. Attention is invited to the new and easy method of squaring numbers by complement and supplement, and especially to the *new* and *wonderful* rule for computing Interest, also to the adaptation of the latter rule to British money.

By this rule, the interest on millions of examples can be accurately computed INSTANTANEOUSLY for three periods of time at *any* rate per cent.

The Rev. Dr. O. P. Fitzgerald, Ex-State Superintendent of Schools, California, says: "I have examined these new methods of calculation; they are remarkable for *originality*, and of great practical value, they are peculiarly clear and comprehensive in their adaptation to all possible cases.

"No Teacher or man of Business can afford to be without them any more than they can afford to travel by *ox teams*, now the *railway* spans the continent."

Professor Warner, President of Elmira Commercial College, says: "I have examined these new methods of calculation—they are invaluable to Teachers and Business men—and will prove a light in science to all coming generations."

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# CALIFORNIA CALCULATOR.

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## DEFINITIONS AND SIGNS.

ARITHMETIC is the science of numbers, and the art of computing by figures.

ABSTRACT NUMBER.—An abstract number is a number used without reference to any particular object, as 9, 745, 9764.

ADDITION, the act of adding, opposed to subtraction.

ALTITUDE, height.

ALIQUOT.—An *aliquot part* of a number is such a part as will exactly divide that number.

AREA, the surface included within any given lines.

ARITHMETICAL SIGNS are characters indicating operations to be performed, and are indispensable for briefly and clearly stating a problem:

+, *plus*, and more, signifying addition;

—, *minus*, less, signifying subtraction;

$\times$, *multiplied by*, as $2 \times 2 = 4$;

$\div$ or : *divided by*, as $6 \div 3 = 2$, or $6 : 3 = 2$, or $\frac{6}{3} = 2$;

$=$, *equality*, or *is equal to*, as $6 + 2 \times 2 = 16$, and is read thus, "6 plus 2, multiplied by 2, equals 16";

$2 : 4 :: 4 : 8$, signs of proportion, to be read "as 2 is to 4 so is 4 to 8";

$\sqrt{9}$, sign of the square root, read "the square root of 9";

$4^2$, sign of the square, read "the square of 4"

$\infty$, indefinitely great, infinite, infinity;

%, *per cent.*

AN ANGLE is the corner formed by two lines where they meet.

BASE, the lower, or side upon which a figure stands; the foundation of a calculation.

CONCRETE NUMBER, used with reference to some particular object or quantity, as 640 acres, 500 dollars.

CIRCLE, a plane figure comprehended by a single curved line, called its *circumference*, every part of which is equidistant from its center.

CIRCUMFERENCE, the line that goes around a circle or sphere.

COMPLEMENT, the difference of a number and some particular number above it, thus: Having 7, what is the *complement* of 10? Ans. 3, the difference of 7 and 10.

CUBE, a solid body with six equal square sides. A product formed by multiplying any number twice by itself, as $4 \times 4 \times 4 = 64$, the *cube* of 4.

CUBE ROOT is the number or quantity which twice multiplied into itself produces the number of which it is the root, thus 4 is the *cube root* of 64.

CURRENCY, the current medium of trade authorized by government.

DIVISION determines how many times any one number is contained in another.

DISCOUNT, the sum deducted from an account, note, or bill of exchange, usually at some rate per cent.

DENOMINATOR, the number placed below the line in fractions, thus, in $\frac{7}{8}$ (seven-eighths) 8 is the *denominator.*

DECIMAL, a tenth; a fraction having some power of 10 for its denominator.

DECIMAL CURRENCY is a currency whose denominations increase or decrease in a ten-fold ratio.

DIVIDEND, the number to be *divided.*

DIVISOR, the number by which the *dividend* is to be *divided.* A *common divisor*, is a number that will *divide* two or more numbers without a remainder.

DIAMETER, a right line passing through any object.

DUODECIMALS are the divisions and subdivisions

of a unit, resulting from continually dividing by 12, as 1, $\frac{1}{12}$, $\frac{1}{144}$, $\frac{1}{1728}$, etc.

Exchange, the receiving or paying of money in one place for an equal sum in another, by order, draft, or bill of exchange.

Fraction, any division of a whole number or unit, thus $\frac{3}{4}$, three-fourths, $\frac{1}{5}$, one-fifth.

An *improper fraction* is a fraction whose *numerator* exceeds its *denominator*.

Factors, numbers, from the multiplication of which proceeds the product; thus, 3 and 4 are the factors of 12.

Figure—A figure is a written sign representing a number.

Integer—An *integer* is a whole number or sum.

Interest, the price or sum per cent. derived from the use of money lent. *Simple interest* is that which arises from the principal sum only. *Compound interest* is that which arises from the *principal* and *interest* added—*interest* on *interest*.

Mathematics, the science of quantities.

Multiplication, adding to zero any given number as many times as there are units in the *multiplier*.

Multiplier, the number that *multiplies;* the multiplier *must* be an abstract number.

Multiplicand, the number *multiplied*.

Mensuration is the art of measuring the areas and solid contents of figures and bodies.

MULTIPLE, a quantity which contains another a certain number of times without a remainder. A *common multiple* of two or more numbers contains each of them a certain number of times, exactly. The *least common multiple* is the *least* number that will do this; 12 is the *least common multiple* of 3 and 4.

NUMBER, a *number* is a unit, or a collection of units. A *prime number* is one that cannot be resolved, or separated into two or more integral factors.

NOTATION, writing numbers.

NUMERATION, reading numbers.

NUMERATOR, the number placed above the line, in fractions; thus, $\frac{5}{9}$ (five-ninths), five is the *numerator*.

POWER—A *power* is the product arising from multiplying a number by itself, or repeating it several times as a factor; thus, $3 \times 3 \times 3$, the product, 27, is a *power* of 3. The *exponent* of a *power* is the number denoting how many times the factor is repeated to produce the *power*, and is written thus: $2^1$, $2^2$, $2^3$.

$2^1 = 2^1 = 2$, the first *power* of 2.
$2 \times 2 = 2^2 = 4$, the second *power* of 2.
$2 \times 2 \times 2 = 2^3 = 8$, the third *power* of 2.

PRINCIPAL, the sum lent on interest, or invested.

PER CENT., from *per centum*, signifying by the hundred; hence, 1 *per cent.* of anything is one-hundredth part of it, 2 *per cent.* is one-fiftieth, etc.

QUADRANGLE, the name of a figure with four sides.

QUANTITY is anything that can be increased, diminished, or measured.

RATIO is the comparison with each other of two numbers of the same kind.

RECIPROCAL is a unit divided by any number. The *reciprocal* of any number or fraction, is that number or fraction inverted; thus the *reciprocal* of $\frac{4}{1}$ is $\frac{1}{4}$, of $\frac{3}{4}$ is ,$\frac{4}{3}$ of $3\frac{1}{3}$ is $\frac{3}{10}$.

RATE PER CENT., the price or sum paid for the use of 100 dollars.

RULE—A *rule* is the prescribed method of performing an operation.

RADIUS, half the diameter of a circle. A right line passing from the center to the circumference.

SUBTRACTION, taking a lesser number from a greater.

SURFACE OF SUPERFICES, the exterior part of anything that has length and breadth.

SUPPLEMENT, the difference of a number and some particular number below it; thus 13, taking 10 as ·he base, the *supplement* is 3, because the difference of 13 and 10 is 3.

SQUARE, a figure having four equal sides, and four right angles. The product of a number

multiplied by itself; thus 16 is the square of 4. $4 \times 4 = 16$.

SQUARE ROOT is the number which multiplied into itself, produces the number of which it is the *root.* 4 is the *root* of 16; $4 \times 4 = 16$.

SPECIE, coin.

SCALE—A scale is a series of numbers regularly ascending or descending.

A SOLID or BODY has length, breadth and thickness.

SPHERE, a body in which every part of the surface is equally distant from the center.

TRIANGLE, a figure with three sides.

TERM—The *terms* of a fraction are numerator and denominator taken together.

UNIT—A unit is *one thing.*

VERTEX, the top of a pyramid or cone.

ZERO, a cipher, or nothing.

In arithmetic, the answer in each operation has a distinctive name. In addition it is called the *sum*; in subtraction, *difference* or *remainder;* in multiplication, the *product;* in division, the *quotient.*

# NOTATION.

All numbers are represented by the ten following figures:

1, one. 2, two, 3, three, 4, four, 5, five, 6, six, 7, seven. 8, eight, 9, nine, 0. ciph'r.

To establish their significance clearly in the mind of the pupil it will be of great advantage occasionally to write and read them in the following manner:

$\frac{1}{1}$ one one, $\frac{2}{1}$ two-ones, $\frac{3}{1}$ three-ones, $\frac{4}{1}$ four-ones, $\frac{5}{1}$ five-ones, $\frac{6}{1}$ six-ones, $\frac{7}{1}$ seven-ones, $\frac{8}{1}$ eight-ones, $\frac{9}{1}$ nine-ones, $\frac{0}{1}$ no ones

The different values which the same figures have, are called *simple* and *local* values.

The *simple* value of a figure is the value it expresses when it stands alone, or in the right hand place.

The *local* value of a figure is the increased value which it expresses by having other figures placed on its right.

Ten is expressed by combining one and cipher, thus, 10; two and cipher combined make twenty, thus, 20, etc. A hundred is expressed by combining the one and two ciphers, thus, 100; two

hundred thus, 200, etc. Ten ones make a ten; ten tens make a hundred; ten hundreds make one thousand; that is, numbers increase from right to left in a ten-fold ratio. Each removal of a figure one place to the left increases its value ten times.

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# NUMERATION.

| Tredecill'ns. | Duodecil'ns. | Undecilli'ns, | Decillions, | Nonillions, | Octillions, | Septillions, | Sextillions, | Quintillions, | Quadrilli'ns, | Trillions, | Billions, | Millions, | Thousands, | Units, |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 121, | 227, | 196, | 497, | 321, | 415, | 716, | 219, | 304, | 196, | 218, | 316, | 415, | 207, | 126. |

To read numbers expressed by figures: Point them off into periods of three figures each, commencing at the right hand; then, beginning at left hand, read the figures of each period in the same manner as those of the right hand period are read, and at the end of each period pronounce its name; thus, 121 tredecillions, 227 duodecillions, 196 undecillions, 497 decillions, 321 nonillions, 415 octillions, 716 septillions, 219 sextillions, 304 quintillions, 196 quadrillions, 218 trillions, 316 billions, 415 millions, 207 thousands, 126.

# ADDITION.

Various suggestions have been made referring to improved methods of addition. In nearly every case the proposed improvement has been more fanciful than real. In practice, I have found no better or quicker method than the following:

```
 3746
 8743
 6978
 1256
 3021
 ----
23744
```

Commence at the bottom of the right hand column; add thus, 7, 15, 18, 24; set down the 4 in unit's place, and carry the two tens to the second column; then add thus, 4, 9, 16, 24; set down the 4 in ten's place, and carry the two hundreds to the third column, and so on to the end. Never add in this manner: 1 and 6 are seven, and 8 are 15, and 3 are 18, and 6 are 24. It is just as easy to name the *sum* at once, omitting the name of each separate figure, and saves two thirds of time and labor.

Book-keepers and others who have long columns of figures to add will find the following methods and suggestions acceptable and very valuable,

## SHORT METHODS OF ADDITION.

Rule of addition for two columns:

$$\begin{array}{r} 24 \\ 86 \\ 31 \\ 19 \\ \hline 160 \end{array}$$

Process — 19 and 31 = 50 and 86 = 136 and 24 = 160.

Rule of addition for three columns:

$$\begin{array}{r} 119 \\ 227 \\ 315 \\ 430 \\ \hline 1091 \end{array}$$

Process—45 and 27 = 72 and 900 = 972 and 119 = 1091.

Any person by practicing these simple methods may become very expeditious.

Fives are always easy to add; so are 9's, when it is borne in mind that adding 9 to a sum places it in the next higher ten with the unit 1 less; thus, $17 + 9 = 26$; $39 + 9 = 48$; $63 + 9 = 72$.

8
4
$7^2$
9
6
5
8
7
9
4
6
8
7
9
8
9

In adding long columns of figures, write in the margin, lightly with pencil, opposite the last figure added, the unit figure of the sum immediately exceeding 100. By doing this the mind is never burdened with numbers beyond 100; and if interrupted in the work, it can be resumed at the stage at which the interruption occurred. The example in the margin shows the method; opposite the figure 7; the 2 indicating the column, so far, with the 7 included, amounts to 102.

### INSTANTANEOUS ADDITION BY COMBINATION.

Write two, three, four, or more rows of miscellaneous figures, then write such figures as will make an equal number of nines in each column; under these again, write another row of miscellaneous figures.

EXAMPLE—

4 9 8 7
4 7 3 6
2 1 8 7
5 0 1 2 one 9.
5 2 6 3 two 9's.
7 8 1 2 three 9's.

3 4 9 8 $\cancel{6}$
3

These first three rows are miscellaneous; the next three are the complement of the first, taking 9 as the base, making the seventh row miscellaneous.

RULE.—To the last row prefix the number of nines, and subtract the number of nines; read 34983.

The foregoing is a very entertaining and profitable exercise for developing the calculating faculty.

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## MULTIPLICATION.

The base of our system of notation is 10; therefore numbers increase and diminish in a tenfold ratio; increasing from the decimal point to the left, and decreasing from the decimal point to the right; hence to multiply any number by 10, annex a cipher, or remove the point one place to the right. To multiply any number by 100, annex two ciphers, or remove the points two places to the right. To multiply any number by 1000, annex three ciphers, or remove the point three places to the right.

To find the product of two numbers, when the multiplicand and the multiplier each contain but two figures.

EXAMPLE 1—

$$\begin{array}{r} 3\ 3 \\ 2\ 2 \\ \hline 7\ 2\ 6 \end{array}$$

EXPLANATION—set down the smaller factor under the larger, units under units, tens under tens. Multiply the units of the multiplicand by the unit figure of the multiplier; thus, $2 \times 3 = 6$, set the 6 down in unit's place; multiply the tens in the multiplicand by the unit figure in the multiplier, and the units in the multiplicand by the tens figure in the multiplier; thus, $3 \times 2 = 6$, and $3 \times 2 = 6$, add these two products together; 6 and 6 are 12; set down 2, carrying the ten to the next product, then multiply the tens in the multiplicand by the tens in the multiplier; thus, $3 \times 2 = 6$; add the one carried from the last product, making the whole product 726.

The same method can be applied when the multiplicand has three or more figures.

EXAMPLE 2—

$$\begin{array}{r} 1\ 6\ 3 \\ 2\ 4 \\ \hline 3\ 9\ 1\ 2 \end{array}$$

The steps are: $3 \times 4 = 12$, set down the 2 and carry the 1; $6 \times 4 + 3 \times 2 + 1 = 31$; set down the 1, and carry the 3. $1 \times 4 + 6 \times 2 + 3 = 19$; set down 9 and carry 1; $1 \times 2 + 1 = 3$, which place at the head of the line, making a total of 3912.

When the multiplier can be resolved into two factors, it is sometimes shorter to multiply by each factor, than by the whole number.

EXAMPLE, multiply 163 by 24.

$8 \times 3 = 24.$

$$\begin{array}{r} 163 \\ 8 \\ \hline 1304 \\ 3 \\ \hline 3912. \end{array} \text{ Ans.}$$

When the multiplier is any number between 11 and 20, the process is simply to multiply by the unit of the multiplier, set down the product under, and one place to the right *of*, and then add *to* the *multiplicand.*

Example, multiply 1496 by 17.

$$\begin{array}{r} 1496\phantom{0} \\ 10472 \\ \hline 25432 \end{array} \text{. Ans.}$$

or thus:

$$\begin{array}{r} 1496 \\ 17 \\ \hline 25432 \end{array}$$

The process in the last example is:

$6 \times 7 = 42$, set down 2 and carry 4.
$9 \times 7 + 6 + 4 = 73$; carry 7.
$4 \times 7 + 9 + 7 = 44$; carry 4.
$1 \times 7 + 4 + 4 = 15$; carry 1.
$1 + 1 = 2$.

*To multiply two figures by* 11.

Rule.—Between the two figures write their sum: thus: multiply 43 by 11. Ans. 473. The sum of

4 and 3 is 7; place the seven between the 4 and 3, for the product.

*To multiply any number by* 11.

RULE.—Bring down the extreme right hand figure, then add the right hand figure to the next, and bring down the product, then add the second figure to the third and bring down the product, adding in the figure carried, in each case, and so on to the end.

EXAMPLE—

$$\begin{array}{r} 1\,2\,3\,4\,5\,6\,7\,8 \\ 1\,1 \\ \hline 1\,3\,5\,8\,0\,2\,4\,5\,8 \end{array}$$

*Process*—8 brought down:

$8 + 7 = 15$, set down 5 and carry 1.
$7 + 6 + 1$, carried, $= 14$, set down 4, carry 1.
$6 + 5 + 1$, carried, $= 12$, set down 2, carry 1.
&c.

*To multiply when the unit figures added, equal* 10, *and the tens are alike, as* $67 \times 63$.

RULE.—Multiply the units and set down the result, then add one to the upper number in tens place, and multiply by the lower.

EXAMPLE—

$$\begin{array}{r} 6\,7 \\ 6\,3 \\ \hline 4\,2\,2\,1 \end{array}$$

The steps are: $7 \times 3 = 21$
$7 \times 6 = 42$

What is the cost of 26 yds of ribbon at 24 cents per yd. Ans. $6.24.

Multiply 86 by 84. Ans. 7224.
Multiply 38 by 32. Ans. 1216.
Multiply 77 by 73. Ans. 5621.

*When the method of squaring numbers is learned, the following rapid method of multiplying may be used:*

RULE.—To find the product of two numbers, square their mean and deduct the square of halt their difference, the result will be the answer.

**NOTE.** The mean of two numbers is the number equidistant between them.

EXAMPLE.—Multiply 22 by 18. Ans. 396.

*Process.*—The mean, or the number equidistant, is 20; the square of 20 is 400, half the difference is 2, the square of 2 is 4; deducted from 400 leaves 396, the answer. Practice the rule with the following and similar examples until expertness is acquired:

19 times 21, 18 times 22, 17 times 23, 16 times 24, 15 times 25, 14 times 26, 29 times 31, 28 times 32, &c. 79 times 81, 78 times 82, &c.

*To multiply two numbers when either have one or more ciphers on the right, as* 26 *by* 20, 244 *by* 200, *&c.*

RULE.—Take the cipher or ciphers from one number and annex it, or them, to the other, multiply by the number expressed by the remaining figures.

EXAMPLE 1.—Multiply 26 by 20. Ans. 520.

*Process.*—$260 \times 2 = 520$.

2.—Multiply 244 by 200. Ans. 48800.

$24400 \times 2 = 48800$.

# LIGHTNING METHOD OF SQUARING NUMBERS.

### BY COMPLEMENT AND SUPPLEMENT.

RULE.—For squaring by SUPPLEMENT. To the number to be squared, add the *supplement*, multiply the sum by the *base*, to the product add the *square* of the supplement, and the sum will be the answer.

NOTE. Take the nearest convenient number that can be divided by 10, without a remainder, for the *base*, the surplus will be the *supplement*.

EXAMPLE 1.—What is the square of 11? Ans. 121.

*Process.*—Taking 10 for the base, the difference or supplement is $1 + 11 \times 10 + 1^2 = 121$.

| | | |
|---|---|---|
| 2.— | $12^2 =$ | 144 |
| 3.— | $13^2 =$ | 169 |
| 4.— | $18^2 =$ | 324 |
| 5.— | $(101)^2 =$ | 10201 |
| 6.— | $(104)^2 =$ | 10816 |
| 7.— | $(106)^2 =$ | 11236 |
| 8.— | $(109)^2 =$ | 11881 |
| 9.— | $(1003)^2 =$ | 1,006,009 |
| 10.— | $(1005)^2 =$ | 1,010,025 |
| 11.— | $(1007)^2 =$ | 1,014,049 |
| 12.— | $(1047)^2 =$ | 1,096,209 |

NOTE. Until this rule is thoroughly understood, the learner should limit his exercises to numbers near 10, 100, 1000, &c.; and then operate with more complex numbers, as under:

$$1.\text{—}\ (22)^2 = 484.$$

*Process.*—Taking 20 for the base, the supplement is, $2 + 22 \times 20 + 2^2 = 484$.

| | |
|---|---|
| 2.— $(33)^2 =$ | 1089 |
| 3.— $(47)^2 =$ | 2209 |
| 4.— $(56)^2 =$ | 3136 |
| 5.— $(68)^2 =$ | 4624 |
| 6.— $(71)^2 =$ | 5041 |
| 7.— $(82)^2 =$ | 6724 |
| 8.— $(93)^2 =$ | 8649 |
| 9.—$(203)^2 =$ | 41,209 |
| 10.—$(322)^2 =$ | 103,684 |
| 11.—$(796)^2 =$ | 633,616 |

*For squaring numbers by the complement.*

RULE.—From the number to be squared *subtract* the complement, *multiply* the result by the base, to the product *add* the square of the complement.

$$1.\ (9)^2 = 81.$$

*Process.*—Taking 10 for the base, the difference or complement is 1, then $9 — 1 \times 10 + 1^2 = 81$.

| | | | |
|---|---|---|---|
| 2.— | $(8)^2$ | = | 64 |
| 3.— | $(19)^2$ | = | 361 |
| 4.— | $(27)^2$ | = | 729 |
| 5.— | $(91)^2$ | = | 8281 |
| 6.— | $(93)^2$ | = | 8649 |
| 7.— | $(96)^2$ | = | 9216 |
| 8.— | $(99)^2$ | = | 9801 |
| 9.— | $(993)^2$ | = | 986,049 |
| 10.— | $(994)^2$ | = | 988,036 |
| 11.— | $(997)^2$ | = | 994,009 |
| 12.— | $(9954)^2$ | = | 99,082,116 |
| 13.— | $(9947)^2$ | = | 98,942,809 |
| 14.— | $(99946)^2$ | = | 9,989,202,916 |
| 15.— | $(99957)^2$ | = | 9,991,401,849 |

NOTE. In squaring numbers between 50 and 60, take 50 for the base; to 25 add the supplement, call the sum hundreds, to this add the square of the supplement.

1.—$(51)^2 = 2601$.

*Process.*—$25 + 1 = 2600 + 1^2 \times = 2601$.

2.—$(52)^2 = 2704$.

NOTE. In squaring numbers between 40 and 50; to 15 add the unit figure, call the number hundreds, to the sum add the square of the complement, taking 50 for the base.

1.—$(41)^2 = 1681$.

*Process.*—$15 + 1 = 1600 + 9^2 = 1681$.

2.—$(42)^2 = 1764$.

3.—$(43)^2 = 1849$.

*To multiply any two numbers together, ending with* $\frac{1}{2}$, *as* $9\frac{1}{2}$ *by* $3\frac{1}{2}$.

RULE.—To the product of the whole numbers, add half their sum, plus $\frac{1}{4}$.

NOTE. When the *sum* is an odd number take half the next number below it, and the fraction in the answer will be $\frac{3}{4}$.

1. What will $9\frac{1}{2}$ lbs. of rice cost, at $3\frac{1}{2}$ cts. per lb? Ans. $33\frac{1}{4}$ cents.

*Process.*—The sum of 9 and 3 is 12; half this sum is 6; then we say 9 times 3 is 27, and 6 is 33; to this add $\frac{1}{4}$.

2. What will $9\frac{1}{2}$ doz. buttons cost, at $8\frac{1}{2}$ cts. per doz? Ans. $80\frac{3}{4}$ cts.

3. What will $11\frac{1}{2}$ lbs. of beef cost, at $9\frac{1}{2}$ cents per lb? Ans. \$$1.09\frac{1}{4}$.

4. What will $7\frac{1}{2}$ doz. eggs cost, at $13\frac{1}{2}$ cents per doz? Ans. \$$1.01\frac{1}{4}$.

*To multiply any two numbers together having the same fraction.*

RULE.—To the product of the whole numbers, add the product of their sum by the fraction; to this add the product of the fractions.

1. What will $13\frac{3}{4}$ lbs. of beef cost, at $7\frac{3}{4}$ cents per lb? Ans. \$$1.06\frac{9}{16}$.

*Process.*—The sum of 13 and 7 is 20, three-fourths of this sum is 15, so we say, 7 times 13 is 91, and 15 is 106, to which add the product of the fractions, ($\frac{9}{16}$) and the result is the Ans. \$$1.06\frac{9}{16}$.

2. What will $12\frac{1}{4}$ lbs. of rice cost, at $6\frac{1}{4}$ cents per lb? Ans. $76\frac{9}{16}$. cents.

3. What will $27\frac{3}{4}$ yds. of cloth cost, at $\$3\frac{3}{4}$ per yard? Ans. $\$104\frac{1}{16}$.

3. What will $12\frac{2}{5}$ ft. of lumber cost, at $8\frac{2}{5}$ cts. per foot? Ans. $\$1.04\frac{4}{25}$.

5. What will $13\frac{5}{8}$ lbs. of cheese cost, at $11\frac{5}{8}$ cts. per lb.? Ans. $\$1.58\frac{25}{64}$.

6. What will $19\frac{1}{4}$ lbs. of beef cost, at $14\frac{1}{4}$ cents per lb. Ans. $\$2.74\frac{5}{16}$.

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# FRACTIONS.

## GENERAL PRINCIPLES OF FRACTIONS.

*Multiplying* the numerator, multiplies the fraction.

*Dividing* the numerator, divides the fraction.

*Multiplying* the denominator, divides the fraction.

*Dividing* the denominator, multiplies the fraction.

*Multiplying* or *dividing* both terms of the fraction by the same number, does not change its value.

Fractions are called similar when they have a common denominator, as $\frac{4}{5}$, $\frac{3}{5}$, $\frac{2}{5}$, $\frac{1}{5}$.

Dissimilar fractions are fractions that are not alike, as $\frac{3}{9}$, $\frac{4}{7}$, $\frac{2}{6}$, $\frac{7}{8}$.

The numerators of similar fractions only can be added.

The common denominator is written under the sum or difference.

*To reduce a fraction to its simplest form.*

RULE.—Divide both terms by their greatest common divisor or its factors, the simplest form, or lowest term of $\frac{36}{48}$, is obtained by dividing both terms by 12, $\frac{36}{48} = \frac{3}{4}$.

*To find the greatest common factor or divisor.*

RULE.—Separate the numbers into their prime factors; the product of all the factors that are common will be the greatest common divisor.

1. What is the greatest common divisor of 12 and 48? Ans. 6.

Process—Separating the numbers into their prime factors, we have $12 = 6 \times 2$; $48 = 6 \times 8$, hence 6 is the greatest common factor or divisor of the two numbers.

2. What is the greatest common divisor of 14 and 42? Ans. 7.
3. What is the greatest common divisor of 5 and 75? Ans. 5.
4. What is the greatest common divisor of 4, 8, 12 and 16? Ans. 4.
5. What is the greatest common divisor of 12, 24, 18 and 36? Ans. 6.

*To find the least common multiple.*

RULE.—Take the product of all the prime factors of that number having the greatest number of prime factors, and this with those prime factors of the other numbers, not found in the factors of the number taken, will be the least common multiple.

1. What is the least common multiple of 4 and 6? Ans. 12.

Process, $2 \times 2 = 4$; $2 \times 3 = 6$; $2 \times 2 \times 3 = 12$, the least common multiple.

2. What is the least common multiple of 18 and 36? Ans. 36.
3. What is the least common multiple of 4, 6, 8, 10? Ans. 120.
4. What is the least common multiple of 2, 3, 4, 5, 6? Ans. 60.
5. What is the least common multiple ot 2, 4, 6, 9 and 18? Ans. 36.

## ADDITION OF FRACTIONS.

RULE.—Make the fractions similar by reducing them to the same denominator; add the numerators, and place the sum over the common denominator.

1. What is the sum of $\frac{2}{3}$ and $\frac{1}{4}$? Ans. $\frac{11}{12}$.
2. What is the sum of $\frac{3}{5}$ and $\frac{1}{2}$? Ans. $1\frac{1}{10}$.
3. What is the sum of $\frac{1}{3}$, $\frac{3}{4}$ and $\frac{1}{2}$? Ans. $1\frac{7}{12}$.
4. What is the sum of $\frac{7}{8}$ and $\frac{5}{9}$? Ans. $1\frac{31}{72}$.
5. What is the sum of $\frac{3}{4}$, $\frac{1}{2}$, $\frac{1}{3}$ and $\frac{1}{5}$?. Ans. $1\frac{47}{60}$.

## SUBTRACTION OF FRACTIONS.

RULE.—Make the fractions similar by reducing them to the same denominator, and write the difference of the numerators over the common denominator.

1. From $\frac{3}{4}$ take $\frac{1}{2}$. Ans. $\frac{1}{4}$.

Process, $\frac{1}{2} = \frac{2}{4}$, $\frac{3}{4} - \frac{2}{4} = \frac{1}{4}$.

2. From $9\frac{1}{3}$ take $4\frac{1}{2}$. Ans. $4\frac{5}{6}$.
3. From $8\frac{1}{2}$ take $3\frac{1}{4}$. Ans. $5\frac{1}{4}$.
4. From $18\frac{3}{4}$ take $3\frac{1}{3}$. Ans. $15\frac{5}{12}$.

## MULTIPLICATION OF FRACTIONS.

RULE.—Multiply the numerators together for a new numerator, and the denominators together for a new denominator.

EXAMPLE.—Multiply $\frac{7}{8}$ by $\frac{2}{5}$.

$$\frac{7}{8} \times \frac{2}{5} = \frac{14}{40} = \frac{7}{20}.$$

General rule for multiplying fractions and all mixed numbers.

RULE.—Multiply the whole numbers together, then multiply the upper whole number by the lower fraction, then multiply the upper fraction by the lower whole number, then multiply the fractions together, and add all the products together.

1. Multiply $8\frac{1}{2}$ by $4\frac{1}{3}$. Ans. $36\frac{5}{6}$.

Process,

$$
\begin{array}{rcr}
 & & 8\frac{1}{2} \\
 & & 4\frac{1}{3} \\
\hline
8 \times 4 & = & 32 \\
8 \times \frac{1}{3} & = & 2\frac{2}{3} \\
\frac{1}{2} \times 4 & = & 2 \\
\frac{1}{2} \times \frac{1}{3} & = & \frac{1}{6} \\
\hline
 & & 36\frac{5}{6}\ \text{Ans.}
\end{array}
$$

2. What will $17\frac{5}{8}$ yards of tape cost at $7\frac{3}{4}$ cents per yard? Ans. $1.36\frac{19}{32}$.

3. What will $73\frac{7}{8}$ acres of land cost at $9\frac{3}{4}$ dollars per acre? Ans. $720\frac{9}{32}$.

4. What will $16\frac{1}{3}$ acres of land cost at $3\frac{1}{4}$ dollars per acre? Ans. $53\frac{1}{12}$.

NOTE.—A very little practice with this rule will enable the learner to do the work mentally, without setting down partial products. In the last example, he would simply say 3 times 16 is 48, $\frac{1}{4}$ of 16 is 4, making 52, and 3 times $\frac{1}{3}$ is 1, making 53, and $\frac{1}{3} \times \frac{1}{4}$ is $\frac{1}{12}$, making a total of $53\frac{1}{12}$ dollars.

In actual business, abbreviate by omitting the fractions in the products, and taking the nearest units; if one-half occurs twice, count one, and perform the last example thus,

$$
\begin{array}{rcr}
16 \times 3 & = & 48 \\
16 \times \frac{1}{4} & = & 4 \\
\frac{1}{3} \times 3 & = & 1 \\
\hline
 & & 53
\end{array}
$$

The answer will be only $\frac{1}{12}$ wrong.

*When the whole numbers are alike, and the sum of the fractions is a unit.*

RULE.—Take the *product* of the whole numbers, to this add the *integer* in the multiplicand, then add the *product* of the fractions, and the result will be the answer.

1. Multiply $2\frac{1}{2}$ by $2\frac{1}{2}$. Ans. $6\frac{1}{4}$.

Process—$2 \times 2 + 2 = 6 + \frac{1}{2} \times \frac{1}{2} = 6\frac{1}{4}$.

2. $3\frac{1}{3} \times$ by $3\frac{2}{3} = 12\frac{2}{9}$.
3. $7\frac{7}{8} \times 7\frac{1}{8} = 56\frac{7}{64}$.
4. $9\frac{5}{8} \times 9\frac{3}{8} = 90\frac{15}{64}$.
5. $19\frac{5}{8} \times 19\frac{3}{8} = 380\frac{15}{64}$
6. $101\frac{4}{5} \times 101\frac{1}{5} = 10302\frac{4}{25}$.
7. $109\frac{9}{13} \times 109\frac{4}{13} = 11990\frac{36}{169}$.
8. $98\frac{9}{14} \times 98\frac{5}{14} = 9702\frac{45}{196}$.
9. $96\frac{7}{9} \times 96\frac{2}{9} = 9312\frac{14}{81}$.
10. $9947\frac{11}{17} \times 9947\frac{6}{17} = 98952756\frac{66}{289}$.
11. $99957\frac{28}{37} \times 99957\frac{9}{37} = 9{,}991{,}501{,}806\frac{252}{1369}$.

The Author of this book claims to be the sole inventor of the above rule. When the learner has mastered our method of squaring numbers, he will be able, with this rule, to find the answers to all such problems, with wonderful and startling rapidity.

*Where the multiplier is the aliquot part of* 100 *or* 1000, *the following table will be useful:*

| | |
|---|---|
| $12\frac{1}{2}$ is $\frac{1}{8}$ part of 100. | $8\frac{1}{3}$ is $\frac{1}{12}$ part of 100 |
| 25 is $\frac{2}{8}$ or $\frac{1}{4}$ of 100. | $16\frac{2}{3}$ is $\frac{2}{12}$ or $\frac{1}{6}$ of 100 |
| $37\frac{1}{2}$ is $\frac{3}{8}$ part of 100. | $33\frac{1}{3}$ is $\frac{4}{12}$ or $\frac{1}{3}$ of 100 |
| 50 is $\frac{4}{8}$ or $\frac{1}{2}$ of 100. | $66\frac{2}{3}$ is $\frac{8}{12}$ or $\frac{2}{3}$ of 100 |
| $62\frac{1}{2}$ is $\frac{5}{8}$ part of 100. | $83\frac{1}{3}$ is $\frac{10}{12}$ or $\frac{5}{6}$ of 100 |
| 75 is $\frac{6}{8}$ or $\frac{3}{4}$ of 100. | 125 is $\frac{1}{8}$ part of 1000 |
| $87\frac{1}{2}$ is $\frac{7}{8}$ part of 100. | 250 is $\frac{2}{8}$ or $\frac{1}{4}$ of 1000 |
| $6\frac{1}{4}$ is $\frac{1}{16}$ part of 100. | 375 is $\frac{3}{8}$ part of 1000 |
| $18\frac{3}{4}$ is $\frac{3}{16}$ part of 100. | 625 is $\frac{5}{8}$ part of 1000 |
| $31\frac{1}{4}$ is $\frac{5}{16}$ part of 100. | 875 is $\frac{7}{8}$ part of 1000 |

*To multiply by the aliquot part of* 100.

**Note.—If the multiplicand is a mixed number, reduce the fraction to a decimal.**

Rule.—Multiply by 100, by annexing two ciphers; such part of the product as the multiplier is part of 100 will be the answer.

Example.—Multiply 86 by $12\frac{1}{2}$. Ans. 1075.

Process—$8600 \div 8 = 1075$.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| To | multiply | by $6\frac{1}{4}$, | annex | two | 0s; | divide by | 16 |
| " | " | $6\frac{2}{3}$, | " | " | " | " | 15 |
| " | " | $8\frac{1}{3}$, | " | " | " | " | 12 |
| " | " | $12\frac{1}{2}$, | " | " | " | " | 8 |
| " | " | $16\frac{2}{3}$, | " | " | " | " | 6 |
| " | " | 25 | " | " | " | " | 4 |
| " | " | 20 | " | " | " | " | 5 |
| " | " | $33\frac{1}{3}$, | " | " | " | " | 3 |
| " | " | 50 | " | " | " | " | 2 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| To multiply | by | 125 | annex | three | 0s; | divide by | 8 |
| " | " | $333\frac{1}{3}$ | " | " | " | " | 3 |
| " | " | $66\frac{2}{3}$ | " | " | " | " | 15 |
| " | " | $83\frac{1}{3}$ | " | " | " | " | 12 |
| " | " | $62\frac{1}{2}$ | " | " | " | " | 16 |
| " | " | $31\frac{1}{4}$ | " | " | " | " | 32 |
| " | " | $166\frac{2}{3}$ | " | " | " | " | 6 |
| " | " | $1\frac{1}{4}$ | " | one | " | " | 8 |
| " | " | $2\frac{1}{2}$ | " | " | " | " | 4 |
| " | " | $3\frac{1}{3}$ | " | " | " | " | 3 |
| " | " | $1\frac{2}{3}$ | " | " | " | " | 6 |

## DIVISION OF FRACTIONS.

RULE.—Reduce whole and mixed numbers to the form of an improper fraction. Multiply the dividend by the divisor inverted.

1. Divide 8 by $1\frac{1}{4}$. Ans. $6\frac{2}{5}$.

Process—$1\frac{1}{4}$ inverted is $\frac{4}{5} \times \frac{8}{1} = \frac{32}{5} = 6\frac{2}{5}$.

2. Divide 6 by $\frac{1}{2}$. Ans. 12.
3. Divide 8 by $\frac{1}{4}$. Ans. 32.
4. Divide $8\frac{1}{2}$ by $7\frac{1}{4}$. Ans. $1\frac{5}{29}$.
5. Divide $7\frac{1}{2}$ by $2\frac{1}{3}$. Ans. $3\frac{3}{14}$.

To divide by $3\frac{1}{3}$: Remove the decimal point one place to the left, and multiply by 3.

To divide by $2\frac{1}{2}$: Remove the point one place to the left, and multiply by four.

To divide by 5: Remove the point one place to the left, and multiply by 2.

To divide by $12\frac{1}{2}$: Remove the point two places to the left, and multiply by 8.

To divide by 25: Remove the point two places to the left, and multiply by 4.

To divide by $33\frac{1}{3}$: Remove the point two places to the left, and multiply by 3.

To divide by 50; Remove the point two places to the left, and multiply by 2.

To divide by $66\frac{2}{3}$: Remove the point two places to the left, multiply by 3 and divide by 2.

*To divide a number by a fraction having* 10 *for the numerator.*

RULE.—Multiply by the denominator and remove the point one place to the left.

Divide 7 5 0 by $1\frac{1}{9}$. Ans. 675.
9
Ans. 6 7 5.0

Divide 4 7 0 by 1 $\frac{3}{7}$. Ans. 329.
7
3 2 9.0

*To divide any number by a fraction having* 100 *for its numerator.*

RULE.—Multiply by the denominator and remove point two places to the left.

EXAMPLE.—Divide 4 5 0 by 14.$\frac{2}{7}$ Ans. 31$\frac{1}{2}$.

```
   4 5 0
       7
 -------
 3 1.5 0
```

Divide 7 5 5 0 by 11$\frac{1}{9}$. Ans. 679$\frac{1}{2}$.

```
   7 5 5 0
         9
 ---------
 6 7 9.5 0
```

# DECIMALS.

### ADDITION AND SUBTRACTION OF DECIMALS

*Are performed in the same manner as in whole numbers; care being taken to properly point off the decimal places.*

### MULTIPLCATION OF DECIMALS.

*The multiplication of decimals is performed in the same manner as in whole numbers; care being taken to properly point off the decimal places in the product.*

RULE.—Multiply as in whole numbers, and point off as many places to the left for decimals as there are decimal places in both factors.

1. Multiply .5 by .5. Ans. .25
2. Multiply 1.75 by .3. Ans. .525.
3. Multiply 27.46 by .4. Ans. 10.984.

When there are not as many figures in the product as there are decimals in both factors, supply the deficiency by prefixing ciphers.

1. Multiply .3 by .3. Ans. .09.
2. Multiply .29 by .004. Ans. .00116.

## DIVISION OF DECIMALS.

*The division of decimals is performed in the same manner as in whole numbers, care being taken to point off the decimal places in the quotient.*

RULE.—Divide as in whole numbers, and point off in the quotient as many places to the left for decimals as the decimal places in the dividend exceed those in the divisor.

Divide .244 by .4. Ans. .61.
Divide .255 by .05. Ans. 5.1.

The learner can supply additional examples at discretion, bearing in mind the following: The *dividend* must always contain, at least, as many decimal places as the *divisor*. When the number of figures in the quotient is less than the excess of the decimal places in the *dividend* over those in the *divisor*, the deficiency must be supplied by prefixing ciphers. When there is a remainder after dividing the dividend, annex ciphers, and continue the division; the ciphers annexed are decimals to the dividend.

# RAPID

# RULES FOR FARMERS.

The practice of buying or selling grain by the 100 pounds, or the *cental* system, is becoming almost universal, and has many advantages over the bushel.

The following rules for finding the relative values of the bushel and the cental are easy to learn, and true and rapid in execution.

*To find the value per cental when the price per bushel is given.*

RULE.—Set down the price per bushel; remove the decimal point two places to the right, and divide by the number of pounds in the bushel.

EXAMPLE.—If wheat is $1.80 per bushel, what is its value per cental? Ans. $3.

Process—

$$60\overline{)180}$$
$$3$$

*To find the value per bushel when the price per cental is given.*

RULE.—Set down the price per cental; multiply by the number of pounds in the bushel, and remove the decimal point two places to the left.

EXAMPLE.—If wheat is $3.00 per cental, what is the value of a bushel? Ans. 1.80.

Process—

$$\begin{array}{r} 3.0\,0\,0 \\ 6 \\ \hline 1.8\,0\,0\,0 \end{array}$$

RAPID RULE FOR RECKONING THE COST OF HAY.

RULE—Multiply the number of pounds by half the price per ton, and remove the decimal point three places to the left.

EXAMPLE.—What is the cost of 764 lbs. of hay at $14 per ton? Ans. $5.348.

Process—

$$\begin{array}{rr} & 7\,6\,4 \\ 14 \div 2 = & 7 \\ \hline & 5.3\,4\,8 \end{array}$$

NOTE.—The above rule applies to anything of which 2,000 pounds is a ton.

## To Measure Grain.

RULE.—Level the grain; ascertain the space it occupies in cubic feet; multiply the number of cubic feet by 8, and point off one place to the left.

EXAMPLE.—A box level full of grain is 20 feet long, 10 feet wide, and 5 feet deep. How many bushels does the box contain? Ans. 800 bush.

Process—$20 \times 10 \times 5 = 1000 \times 8 \div 10 = 800.$

Or,

$$\begin{array}{r} 1\,0\,0\,0 \text{ ft.} \\ 8 \\ \hline 8\,0\,0.0 \end{array}$$

NOTE.—Exactness requires the addition to every three hundred bushels of one extra bushel.

The foregoing rule may be used for finding the number of gallons, by multiplying the number of bushels by 8.

If the corn in the box is in the ear, divide the answer by 2, to find the number of bushels of shelled corn, because it requires two bushels of ear corn to make one of shelled corn.

## RAPID RULES FOR MEASURING LAND WITHOUT INSTRUMENTS.

In measuring land, the first thing to ascertain is the contents of any given plot in square yards; then, given, the number of yards, find out the number of rods and acres.

The most ancient and simplest measure of distance is a step. Now, an ordinary-sized man can train himself to cover 1 yard at a stride, on the average, with sufficient accuracy for ordinary purposes.

To make use of this means of measuring distances, it is essential to walk in a straight line; to do this, fix the eye on two objects in a line straight ahead, one comparatively near, the other remote;

and, in walking, keep these objects constantly in line.

*Farmers and others by adopting the following simple and ingenious contrivance, may always carry with them the scale to construct a correct yard measure.*

Take a foot rule, and commencing at the base of the little finger of the left hand, mark the quarters of the foot on the outer borders of the left arm, pricking in the marks with indelible ink.

*To find the area of all four-sided figures, two of whose sides are parallel.*

RULE.—Multiply the length and the breadth together, and the product is the area.

*To find the area of a square, square one of its sides.*

RULE.—When the length of two opposite sides is unequal, add them together, and take half the sum.

EXAMPLE 1. How many square yards in a square piece of land, 101 feet on each side?

Process—$101^2 =$ Ans. 10,201 yards.

EXAMPLE 2. How many yards in a piece of land 60 yards long and 20 yards wide? Ans. 1200.

Process—$600 \times 2 = 1200$.

EXAMPLE 3. How may yards in a piece of land, one side is 40 yards long, and the other side 60 yards long, parallel sides being 10 yards apart?

$$\text{Process,} \qquad \frac{40 + 60 \times 10}{2} = 500.$$

500 yards, Ans.

*To find the area of all three-sided figures.*

RULE.—Multiply the longest side into one-half the distance from this side to the opposite angle.

EXAMPLE.—What is the area of a triangular plot of land, the longest side of which is 80 yards, and the shortest distance from this side to the opposite angle 40 yards?

$$\text{Process,} \quad \frac{40}{2} = 20, 80 \times 20 = 1600 \text{ yds. Ans.}$$

*To find how many rods in length will make an acre, the width being given.*

RULE.—Divide 160 by the width, and the quotient will be the answer.

EXAMPLE.—If a piece of land be 4 rods wide, how many rods in length will make an acre?

$160 \div 4 = 40$ rods Ans.

*To find the number of acres in any plot of land, the number of rods being given.*

RULE.—Divide the number of rods by 8, and the quotient by 2, and remove the decimal point one place to the left.

EXAMPLE.—In 6840 rods how many acres?

42¾ acres Ans.

**Process,**

$$8\,)\,6840$$
$$2\,)\,855$$
$$42.75$$

In some cases the method of cancelling may be applied with advantage.

EXAMPLE.—A square plot of land measures 48 rods on each side, how many acres? $14\frac{4}{10}$.

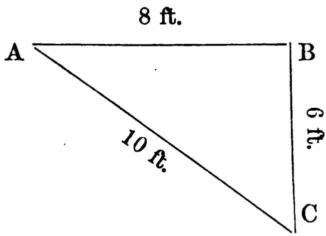
Process—Cancel by dividing each of the upper terms by the lower terms.

$$6 \times 24 = 144.$$
$$\frac{\cancel{48} \times \cancel{48}}{\cancel{8} \times \cancel{2}}$$

# RAPID

# RULES FOR MECHANICS.

To lay off a square corner.—Measure off eight feet from the end of one sill, and there make a mark; then measure off six feet on the sill lying at right angles with the first, and make another mark; then lay on a ten foot pole, one end of it squarely with the first mark. Move the sill in or out until it exactly squares with it. The figure thus made in marking off the sills, and in the laying down the ten foot pole is a right angle triangle.




*Another method for laying off a square corner.*

Take a measure and lay off with it a triangle, one side of which is four feet long, another three feet, and the remaining side five feet. This triangle will be right angled, and the two shorter sides will serve to lay off an exact square.

## To Measure Grindstones.

Grindstones are measured by the cubic foot, 24 inches diameter, by 4 inches in thickness, is 1728 cubic inches, or 1 cubic foot.

RULE.—Add the diameter to half the diameter, multiply the sum by the same half, multiply the product by the thickness, divide the last product by 1728, for the answer.

EXAMPLE.—How many feet in a grindstone 24 inches in diameter, and 4 inches thick?

Ans. 1 foot.

Process—$24 + 12 \times 12 \times 4 = 1728$ inches.

## Measure of Superfices and Solids.

Superficial measure is that which relates to length and breadth only, not regarding thickness. It is made up of squares, either greater or less, according to the different measures by which the dimensions of the figure are taken or measured. Land is measured in this way, its dimensions being taken in inches, feet and yards, or links, rods and acres. The contents of boards also, are found in this way, their dimensions being taken in feet and inches. The standard of measure is as follows: 12 inches in length make one foot of long measure; therefore, $12 \times 12 = 144$, the square inches in a superficial foot.

1. If the floor of a room be 20 feet long by 18 feet wide, how many square feet are contained in it? Ans. 360 feet.

Process—$180 \times 2 = 360$.

2. If a board be 4 inches wide, how much in length will make a foot square? Ans. 36 inches.

Process—144 divided by the width, thus, $\frac{144}{4} = 36$.

3. If a board be 21 feet long and 18 inches broad, how many square feet are contained in it?

Ans. $31\frac{1}{2}$ sq. ft.

Process—Multiply the length in feet by the breadth in inches, and divide the product by 12.

$$\frac{21 \times \overset{3}{\cancel{18}}}{\underset{2}{\cancel{12}}} = 31\tfrac{1}{2}.$$

Or thus, 18 inches equals $1\frac{1}{2}$ ft.; $21 \times 1\frac{1}{2} = 31\frac{1}{2}$.

*To measure a board wider at one end than the other, of a true taper.*

Rule.—Add the widths of both ends together; halve the sum for the mean width, and multiply the mean width by the length.

EXAMPLE.—How many square feet in a board 20 feet long, 9 inches in width at one end, and 11 inches at the other? Ans. $16\frac{2}{3}$ sq. ft.

Process—

$$\frac{9 + 11}{2} = 10 \text{ in., mean width; } \frac{20 \times 10}{12} = 16\tfrac{2}{3}.$$

*To find the board measure of planks and joists.*

RULE.—Find the contents of one side of the plank or joist by the preceding rule, and multiply the result by the thickness in inches.

EXAMPLE.—What is the board measure of a plank 18 feet long, 10 inches wide, and 4 inches thick?

Ans. 60 ft.

Process— $$\frac{18 \times 10}{12} = 15 \times 4 = 60.$$

*The diameter being given, to find the circumference.*

RULE.—Multiply the diameter by $3\frac{1}{7}$.

EXAMPLE.—What is the circumference of a wheel the diameter of which is 42 inches? Ans. 11 ft.

Process— $$\frac{\overset{3\frac{1}{2}}{\cancel{42}} \times 3\frac{1}{7}}{\cancel{12}} = 11 \text{ feet.}$$

*To find the diameter when the circumference is given.*

RULE.—Divide the circumference by $3\frac{1}{7}$.

EXAMPLE.—What is the diameter of a wheel, the circumference of which is 11 feet? Ans. $3\frac{1}{2}$ feet.

Process— $$\frac{\cancel{11}}{1} \times \frac{7}{\underset{2}{\cancel{22}}} = 3\frac{1}{2}$$

What is the width of a circular pond, 154 rods in circumference? 49 rods Ans.

Process— $$\frac{\overset{7}{\cancel{154}}}{1} \times \frac{7}{\cancel{22}} = 49.$$

*To find how many solid feet a round stick of timber of the same thickness throughout, will contain when squared.*

RULE.—Square half the diameter in inches, multiply by 2, multiply by the length in feet, and divide the product by 144.

EXAMPLE.—How many solid feet, when squared, in a round log, 24 inches wide and 10 feet long?

Ans. 20 feet.

Process— $$\frac{\cancel{144} \times 2 \times 10}{\cancel{144}} = 20.$$

*General rule for measuring timber, to find the solid contents in feet.*

Rule.—Multiply the depth in inches by the breadth in inches, and then multiply by the length in feet, and divide by 144.

Example.—How many solid feet in a piece of timber 24 inches wide, 10 inches thick, and 12 feet long? 20 feet Ans.

Process— $$\frac{\overset{2}{\cancel{24}} \times 10 \times \cancel{12}}{\underset{\cancel{12}}{\cancel{144}}} = 20.$$

*To find the contents of a true tapered pyramid, whether round, square or triangular.*

Rule.—Multiply the area of the base by one third the height, and divide by 144.

Example.—How many cubic feet in a round stick of timber, truly tapering to a point, 18 inches in diameter at the base, and twenty-four feet long? Ans. 14.1372 feet.

Process—$3.1416 \times 81 \times 8 \div 144 = 14.1372$.

2. How many cubic feet in a square block of

marble, truly tapering to a point, 24 inches on each side at the base, and twelve feet high.

Ans. 16 feet.

$$\text{Process—}24 \times 24 = \frac{\overset{4}{\cancel{576}} \times 4}{\cancel{144}} = 16.$$

*To find the number of feet of timber in trees with the bark on.*

RULE.—Multiply the square of one-fifth of the circumference, in inches, by twice the length, in feet, and divide by 144. Deduct $\frac{1}{10}$ to $\frac{1}{15}$ according to the thickness of the bark.

EXAMPLE.—How many feet in the trunk of a tree 72 feet long, and 15 feet in circumference?

Ans. 1,296 ft.

Process—

$$\frac{1296 \times \cancel{144}}{\cancel{144}} = 1296 \text{ ft.}$$

## Bricklayers' Work

Is sometimes measured by the perch, but more frequently by the 1000 bricks laid in the wall.

The following scale will give a fair average for estimating the quantity of brick required to build a given amount of wall:

| | | | | | |
|---|---|---|---|---|---|
| $4\frac{1}{2}$ in. wall, | per ft., | superficial, | ($\frac{1}{2}$ brick) | 7 | bricks. |
| 9 " | " | " | (1 brick) | 14 | " |
| 13 " | " | " | ($1\frac{1}{2}$ brick) | 21 | " |
| 18 " | " | " | (2 bricks) | 28 | " |
| 22 " | " | " | ($2\frac{1}{2}$ bricks) | 35 | " |

NOTE.—For each half brick added to the thickness of the wall, add seven bricks.

A bricklayer's hod measuring 1 ft. 4 in. × 9 in. × 9 in., equals 1,296 inches in capacity, and will contain 20 bricks.

A load of mortar measures 1 cubic yard, or 27 cubic feet; requires 1 cubic yard of sand, and 9 bushels of lime, and will fill 30 hods.

## Plasterers' Work

Is measured by the square yard, for all plain work: by the foot, superficial, for plain cornices; and by foot, lineal, for enriched or carved mouldings in cornices.

## Painters' Work

Is computed by the superficial yard; every part is measured that is painted, and an allowance is added for difficult cornices, deep mouldings, carved surfaces, iron railings, etc. Charges are usually made for each coat of paint put on, at a certain price per yard per coat.

## Mehtode zu sagen den Tag auf die Woche nach jedem Datum von Christi Geburt dreitausend Jahr.

Methode.—Streich die Sieben aus von die beiden letzten Nummern auf das Jahr, der Minuent von den beiden letzten Nummern im Jahre, dividirt bei vier—gebrauche nicht den Rest—den Datum auf den Monat, und die Figur auf das Jahr. Was überbleibt ist der Tag in der Woche, der erste Sonntag, der zweite Montag u. s. w.

### Die Figuren vor die Monate.

1 vor Sept. u. Decbr. 8 vor Jan. u. Oct. 5 vor August. 0 vor Juni.
2 vor April und Juli. 4 vor Mai. 6 vor Feb., März, Nov.

Der Datum im Januar und Februar ist ein weniger im Schaltjahr.

### Datum auf die Jahre.

1, ist die Figur vor das 2te, 9te und 16te Jahrhundert.
2, „ „ „ „ „ 1te, 8te, 15te, 18te, 22te, 26te und 30te Jahrhundert.
3, „ „ „ „ „ 8te, 7te, 14te Jahrhundert.
4, „ „ „ „ „ 6te, 13te, 17te, 21te, 25te, 29te Jahrhundert.
5, „ „ „ „ „ 5te, 12te, 20te, 24te, und 28te Jahrhundert.
6, „ „ „ „ „ 4te nnd 11 Jahrhundert.
0, „ „ „ „ „ 8te, 10te, 19te, 23te und 27te Jahrhundert.

Exempel.—Welcher Tag in der Woche war der 31. August, 1873? Antwort, Sonntag.

| | |
|---|---|
| Die letzten beiden Figuren im Jahre, | 73 — 70 = 3 |
| Minuent auf do. ÷ bei vier, | 18 + 3 — 21 = 0 |
| Datum im Monat, | 31 — 28 = 3 |
| Figur auf den Monat, | 5 + 3 — 7 = 1 |

Der Rest 1 zeigt Euch den ersten Tag in der Woche, welcher ist Sonntag.

## To Find the Difference of Time between

RULE.—Opposite the day of the month is writ-
pired, subtract this number from the whole num-

| January | | February | | March | | April | | May | | June | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 1 | 32 | 1 | 60 | 1 | 91 | 1 | 121 | 1 | 152 |
| 2 | 2 | 2 | 33 | 2 | 61 | 2 | 92 | 2 | 122 | 2 | 153 |
| 3 | 3 | 3 | 34 | 3 | 62 | 3 | 93 | 3 | 123 | 3 | 154 |
| 4 | 4 | 4 | 35 | 4 | 63 | 4 | 94 | 4 | 124 | 4 | 155 |
| 5 | 5 | 5 | 36 | 5 | 64 | 5 | 95 | 5 | 125 | 5 | 156 |
| 6 | 6 | 6 | 37 | 6 | 65 | 6 | 96 | 6 | 126 | 6 | 157 |
| 7 | 7 | 7 | 38 | 7 | 66 | 7 | 97 | 7 | 127 | 7 | 158 |
| 8 | 8 | 8 | 39 | 8 | 67 | 8 | 98 | 8 | 128 | 8 | 159 |
| 9 | 9 | 9 | 40 | 9 | 68 | 9 | 99 | 9 | 129 | 9 | 160 |
| 10 | 10 | 10 | 41 | 10 | 69 | 10 | 100 | 10 | 130 | 10 | 161 |
| 11 | 11 | 11 | 42 | 11 | 70 | 11 | 101 | 11 | 131 | 11 | 162 |
| 12 | 12 | 12 | 43 | 12 | 71 | 12 | 102 | 12 | 132 | 12 | 163 |
| 13 | 13 | 13 | 44 | 13 | 72 | 13 | 103 | 13 | 133 | 13 | 164 |
| 14 | 14 | 14 | 45 | 14 | 73 | 14 | 104 | 14 | 134 | 14 | 165 |
| 15 | 15 | 15 | 46 | 15 | 74 | 15 | 105 | 15 | 135 | 15 | 166 |
| 16 | 16 | 16 | 47 | 16 | 75 | 16 | 106 | 16 | 136 | 16 | 167 |
| 17 | 17 | 17 | 48 | 17 | 76 | 17 | 107 | 17 | 137 | 17 | 168 |
| 18 | 18 | 18 | 49 | 18 | 77 | 18 | 108 | 18 | 138 | 18 | 169 |
| 19 | 19 | 19 | 50 | 19 | 78 | 19 | 109 | 19 | 139 | 19 | 170 |
| 20 | 20 | 20 | 51 | 20 | 79 | 20 | 110 | 20 | 140 | 20 | 171 |
| 21 | 21 | 21 | 52 | 21 | 80 | 21 | 111 | 21 | 141 | 21 | 172 |
| 22 | 22 | 22 | 53 | 22 | 81 | 22 | 112 | 22 | 142 | 22 | 173 |
| 23 | 23 | 23 | 54 | 23 | 82 | 23 | 113 | 23 | 143 | 23 | 174 |
| 24 | 24 | 24 | 55 | 24 | 83 | 24 | 114 | 24 | 144 | 24 | 175 |
| 25 | 25 | 25 | 56 | 25 | 84 | 25 | 115 | 25 | 145 | 25 | 176 |
| 26 | 26 | 26 | 57 | 26 | 85 | 26 | 116 | 26 | 146 | 26 | 177 |
| 27 | 27 | 27 | 58 | 27 | 86 | 27 | 117 | 27 | 147 | 27 | 178 |
| 28 | 28 | 28 | 59 | 28 | 87 | 28 | 118 | 28 | 148 | 28 | 179 |
| 29 | 29 | | | 29 | 88 | 29 | 119 | 29 | 149 | 29 | 180 |
| 30 | 30 | | | 30 | 89 | 30 | 120 | 30 | 150 | 30 | 181 |
| 31 | 31 | | | 31 | 90 | | | 31 | 151 | | |

## The Dates by the Following Table.

ten the number of days of the year which have ex-
ber of days that have expired at the date required.

| July | | August | | Sept. | | October | | Nov. | | Dec. | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 182 | 1 | 213 | 1 | 244 | 1 | 274 | 1 | 305 | 1 | 335 |
| 2 | 183 | 2 | 214 | 2 | 245 | 2 | 275 | 2 | 306 | 2 | 336 |
| 3 | 184 | 3 | 215 | 3 | 246 | 3 | 276 | 3 | 307 | 3 | 337 |
| 4 | 185 | 4 | 216 | 4 | 247 | 4 | 277 | 4 | 308 | 4 | 338 |
| 5 | 186 | 5 | 217 | 5 | 248 | 5 | 278 | 5 | 309 | 5 | 339 |
| 6 | 187 | 6 | 218 | 6 | 249 | 6 | 279 | 6 | 310 | 6 | 340 |
| 7 | 188 | 7 | 219 | 7 | 250 | 7 | 280 | 7 | 311 | 7 | 341 |
| 8 | 189 | 8 | 220 | 8 | 251 | 8 | 281 | 8 | 312 | 8 | 342 |
| 9 | 190 | 9 | 221 | 9 | 252 | 9 | 282 | 9 | 313 | 9 | 343 |
| 10 | 191 | 10 | 222 | 10 | 253 | 10 | 283 | 10 | 314 | 10 | 344 |
| 11 | 192 | 11 | 223 | 11 | 254 | 11 | 284 | 11 | 315 | 11 | 345 |
| 12 | 193 | 12 | 224 | 12 | 255 | 12 | 285 | 12 | 316 | 12 | 346 |
| 13 | 194 | 13 | 225 | 13 | 256 | 13 | 286 | 13 | 317 | 13 | 347 |
| 14 | 195 | 14 | 226 | 14 | 257 | 14 | 287 | 14 | 318 | 14 | 348 |
| 15 | 196 | 15 | 227 | 15 | 258 | 15 | 288 | 15 | 319 | 15 | 349 |
| 16 | 197 | 16 | 228 | 16 | 259 | 16 | 289 | 16 | 320 | 16 | 350 |
| 17 | 198 | 17 | 229 | 17 | 260 | 17 | 290 | 17 | 321 | 17 | 351 |
| 18 | 199 | 18 | 230 | 18 | 261 | 18 | 291 | 18 | 322 | 18 | 352 |
| 19 | 200 | 19 | 231 | 19 | 262 | 19 | 292 | 19 | 323 | 19 | 353 |
| 20 | 201 | 20 | 232 | 20 | 263 | 20 | 293 | 20 | 324 | 20 | 354 |
| 21 | 202 | 21 | 233 | 21 | 264 | 21 | 294 | 21 | 325 | 21 | 355 |
| 22 | 203 | 22 | 234 | 22 | 265 | 22 | 295 | 22 | 326 | 22 | 356 |
| 23 | 204 | 23 | 235 | 23 | 266 | 23 | 296 | 23 | 327 | 23 | 357 |
| 24 | 205 | 24 | 236 | 24 | 267 | 24 | 297 | 24 | 328 | 24 | 358 |
| 25 | 206 | 25 | 237 | 25 | 268 | 25 | 298 | 25 | 329 | 25 | 359 |
| 26 | 207 | 26 | 238 | 26 | 269 | 26 | 299 | 26 | 330 | 26 | 360 |
| 27 | 208 | 27 | 239 | 27 | 270 | 27 | 300 | 27 | 331 | 27 | 361 |
| 28 | 209 | 28 | 240 | 28 | 271 | 28 | 301 | 28 | 332 | 28 | 362 |
| 29 | 210 | 29 | 241 | 29 | 272 | 29 | 302 | 29 | 333 | 29 | 363 |
| 30 | 211 | 30 | 242 | 30 | 273 | 30 | 303 | 30 | 334 | 30 | 364 |
| 31 | 212 | 31 | 243 | | | 31 | 304 | | | 31 | 365 |

## Howard's California Calendar for Thirty Centuries.

RULE.—Cast the sevens out of the last two figures of the year, the quotient of the two last figures of the year divided by four—disregarding the remainder, if any—the day of the month, the figure for the month, and the figure for the century. One remainder will be the first day of the week; 2, second; 0, last day of the week.

TABLE OF FIGURES FOR THE MONTHS.

| | | | |
|---|---|---|---|
| 1, Sept. and Dec. | 3, Jan. and Oct. | 5, August. | 0, June. |
| 2, April and July. | 4, May. | 6, Feb., March, Nov. | |

NOTE.—The figure for January is 2, and February 5 in leap year.

TABLE OF FIGURES FOR THE CENTURIES.

1, is the figure for the 2d, 9th, and 16th centuries.
2, " " " " " 1st, 8th, 15th, 18th, 22d, 26th, 30th centuries.
3, " " " " " 7th, 14th centuries.
4, " " " " " 6th, 13th, 17th, 21st, 25th, 29th centuries.
5, " " " " " 5th, 12th, 20th, 24th, 28 centuries.
6, " " " " " 4th, 11th centuries.
0, " " " " " 3d, 10th, 19th, 23th. 27th centuries.

EXAMPLE.—What day of the week was the 31st August, 1873? Sunday, Ans.

Process—

| | |
|---|---|
| Last two figures of the year, | 73 — 70 = 3 |
| Quotient of Do. ÷ by four, | 18 + 3 — 21 = 0 |
| Day of month, | 31 — 28 = 3 |
| Figure for the month, | 5 + 3 — 7 = 1 |
| Figure for the century, | 0 |

After casting out the sevens the remainder is 1: hence it was on the first day of the week, Sunday.

N. B.—The even centuries not divisable by 400 are not leap years.

# PROPORTION.

*Proportion* is the equality of ratios.

*Ratio* is the relation which one quantity bears to another of the same kind, with reference to the number of times that the less is contained in the greater.

Thus, the ratio of 7 to 21 is 3, because 7 is contained 3 times in 21, or 21 is 3 times seven. The same result is obtained if we divide 7 by 21, for we then find $\frac{7}{21} = \frac{1}{3}$, which means that 7 is $\frac{1}{3}$ of 21, and this expresses the very same relation as before, to say that 7 is $\frac{1}{3}$ of 21 is precisely the same as to say that 21 is 3 times 7. The ratio of 9 to 27 is 3, but we have seen that the ratio of 7 to 21 is also 3, therefore, the ratios of 7 to 21 and 9 to 27 are the same, $21 \div 7 = 27 \div 9$, and these quantities are thefore called proportionals.

In any proportion, as

$$7 : 21 :: 9 : 27$$

the product of the middle numbers, 21 and 9, equals the product of the extremes, 7 and 27: hence the *rule*, that when the fourth proportional is unknown,

Multiply the second and third terms, and divide the product by the first.

Example.—If 7 sheep cost 21 dollars, what will 9 cost at the same rate? 27 dollars, Ans.

$$\begin{array}{lr} \text{2d term,} & 21 \\ \text{3d term,} & 9 \\ \hline \text{1st term, } 7) & 189 \\ \hline & 27 \end{array} \qquad \text{Or thus, } \frac{\overset{3}{\cancel{21}} \times 9}{\cancel{7}} = 27$$

Proportion is so much used in business, and may be simplified and shortened so much by the foregoing process of cancellation, that the pupil *must* learn both before he can hope to be expert with business calculations.

CANCELLING IN CALCULATION.—Whenever it is reqnired to multiply two or more numbers together, and divide by a third, the first step is to state the problem in its most manageable form; this can only be done by the use of the arithmetical signs.

The statement $\dfrac{28 \times 12}{14}$ is to be read, 28 multiplied by 12 is to be divided by 14.

Stating the problem as above we see at a glance if the divisor is contained, and how many times, in either of the multipliers.

In the foregoing example the divisor, 14, is contained twice in the multiplier, 28; then cancel the 14 and substitute 2 for the 28, and say, twice 12 is 24 the answer.

Process, $$\frac{\overset{2}{\cancel{28}} \times 12}{\cancel{14}} = 24.$$

EXAMPLE.—If 9 turkeys cost \$18, what will be the cost of 27?

$$\frac{18 \times \overset{3}{\cancel{27}}}{\cancel{9}} = \$54, \text{ Answer.}$$

If the divisor is not contained evenly in either of the multipliers, there may be a common divisor for the divisor itself and one of the multipliers; if so, the common divisor may be used in cancelling, thus:

$$\frac{\overset{7}{\cancel{63}} \times 8}{\underset{3}{\cancel{27}}} = 18\tfrac{2}{3}, \text{ Ans.}$$

A glance shows that 9 is the common divisor for 63 and 27.

When a common divisor has been used to change the expression of the divisor and one of the multipliers, the new divisor may be cancelled when it is contained an even number of times in the other multiplier.

EXAMPLE—

$$\frac{\overset{7}{\cancel{63}} \times \overset{2}{\cancel{8}}}{\cancel{36} \quad \cancel{4}} = 14.$$

Process—36 and 63 divided by 9, the common divisor, becomes 4 and 7 respectively, the 4 into 8, 2 times, cancel 4 and 8, and twice 7 is 14, the answer.

When fractions are involved in the calculation, state each term in the form of fractions, taking care to *invert* the divisor.

EXAMPLE.—If 7 inches of velvet cloth cost $2\frac{1}{2}$ dollars, what will be the cost of 7 yards? $90, Ans.

Process, $$\frac{5}{\cancel{2}} \times \frac{\cancel{7}}{1} \times \frac{\overset{18}{\cancel{36}}}{\cancel{7}} = 90.$$

NOTE.—$2\frac{1}{2}$ dollars $= \frac{5}{2}$, 7 yards is $\frac{7}{1}$, 7 inches is $\frac{7}{36}$ of a yard, $\frac{7}{36}$ inverted is $\frac{36}{7}$.

*Summary of the rapid* process for *cancelling.*

1. Draw a horizontal line; above the line write dividends only; below the line write divisors only.

2. If there are ciphers above and below the line, erase an equal number on either side; 1 standing alone may be disregarded.

3. If the *same* number stands above and below the line, erase them *both.*

4. If any number on either side of the line will divide any number on the other side of the line without a remainder, divide, and erase the two numbers, retaining the quotient figure on the side of the larger number.

5. If any two numbers on either side have a common divisor, divide them by that number, and retain the quotients only.

6. Multiply all the numbers above the line for a dividend, and those below the line for a divisor; divide, and the quotient is the answer.

The foregoing process may be applied to computing Interest.

Rule.—Place the *principal*, *rate %* and *number* of days for which interest is sought, above the line for dividends, then 36 below the line for a divisor.

Example.—Find the interest on $350 for 40 days, at 9 % per annum?

$$\frac{350 \times \overset{10}{\cancel{40}} \times \cancel{9}}{\cancel{36} \quad \cancel{4}} \qquad \$3.500, \text{ Ans.}$$

Process—The 9 cancels the 36, leaving 4, this 4 cancels the remaining 40 above the line, leaving 350 × 10 for the answer.

Find the interest on $99 for 23 days, at 4 % per annum.

$$\frac{\overset{11}{\cancel{99}} \times 23 \times \cancel{4}}{\cancel{9} \quad \cancel{36}} \qquad \$.253, \text{ Ans.}$$

## MARKING GOODS.

Removing the decimal point one place to the left on the cost of a dozen articles, gives the cost of one article with 20 per cent. added. We remove the point one place to the left, because 12 tens make 120. Hence, to find the selling price, to gain

the required percentage of profit, we have the following general rule:

RULE.—Remove the decimal point one place to the left on the cost per dozen, to gain 20 per cent.; increase or diminish to find the percentage, as per following table:

TABLE FOR MARKING ALL GOODS BOUGHT BY THE DOZEN.

To make 20% remove the point 1 place to left.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| " | 25% | " | " | " | " | Add | $\frac{1}{24}$ | itself. |
| " | 26% | " | " | " | " | " | $\frac{1}{20}$ | " |
| " | 28% | " | " | " | " | " | $\frac{1}{15}$ | " |
| " | 30% | " | " | " | " | " | $\frac{1}{12}$ | " |
| " | 32% | " | " | " | " | " | $\frac{1}{10}$ | " |
| " | $33\frac{1}{3}$% | " | " | " | " | " | $\frac{1}{9}$ | " |
| " | 35% | " | " | " | " | " | $\frac{1}{8}$ | " |
| " | $37\frac{1}{2}$% | " | " | " | " | " | $\frac{1}{7}$ | " |
| " | 40% | " | " | " | " | " | $\frac{1}{6}$ | " |
| " | 44% | " | " | " | " | " | $\frac{1}{5}$ | " |
| " | 50% | " | " | " | " | " | $\frac{1}{4}$ | " |
| " | 60% | " | " | " | " | " | $\frac{1}{3}$ | " |
| " | 80% | " | " | " | " | " | $\frac{1}{2}$ | " |
| " | $12\frac{1}{2}$% | " | " | " | " | subtract | $\frac{1}{16}$ | " |
| " | $16\frac{2}{3}$% | " | " | " | " | " | $\frac{1}{36}$ | " |
| " | $18\frac{3}{4}$% | " | " | " | " | " | $\frac{1}{96}$ | " |

If hats cost $20 per dozen, at what price are they to be sold to gain 20 per cent. profit? Ans. $2.00.

If hats cost $20 per dozen, at what price are they to be sold to gain 50 per cent. profit? Ans. $2.50.

EXPLANATION.—Removing the point one place to

the left on $20.00 gives us two dollars; to this add ¼ itself (50 cents), and we have the price at which to sell, to gain 50 per cent profit.

## To Find the Value of Currency when Gold is at a Stated Price and vice versa.

RULE.—Take 100 for the numerator, and the value of gold or currency, as the case may be, for the denominator; reduce the fraction to its lowest terms; annex two ciphers to the numerator, and divide by the denominator.

EXAMPLE 1. Find the value of gold, the price of greenbacks being 75 cents? Ans. 133⅓.

Process— $\frac{100}{75} = \frac{4}{3}, \quad \frac{400}{3}\ 1.33\tfrac{1}{3}.$

2. Find the value of currency, the price of gold being 133⅓. Ans. 75 cents.

Process— $\frac{100}{133\frac{1}{3}} = \frac{3\cancel{0}\cancel{0}}{4\cancel{0}\cancel{0}}, \quad \frac{300}{4} = 75.$

3. Find the value of gold, the price of currency being 80 cents. Ans. 125.

4. Find the value of currency, the price of gold being $1.25. Ans. 80 cents.

## Howard's New Rule

# FOR COMPUTING INTEREST.

Interest, in the various forms under which it accrues, has so large a place in every day business transactions, that a rapid and accurate method of computing *interest* is one of the most indispensable items of business knowledge.

The one that I present here, in all respects, is, without exception, the *newest*, the *easiest to learn*, and *use*, the *quickest* and *most correct* one in existence, adapted to *all sums*, *all periods*, and *all rates per cent.*

Under this rule, by the simple operation of *inverting* the rate, the interest is found in the twinkling of an eye, without the possibility of making a mistake, for three periods of time, and that without altering one figure of the principal; to find the interest for any other time, is then merely a question of increasing or diminishing the result to suit the time given. One or more of the periods found will always supply a convenient base to work from, to find the interest for any other time. The rule is founded upon the following general and simple principles: Divide 100 by the rate, and the quotient is the time when the interest equals the prin-

cipal, and the decimal point remains the same; divide 10 by the rate, and the quotient indicates the time when the interest will be shown by removing the decimal point one place to the left, divide unity by the rate, and the quotient is the time for which the interest will be shown by removing the decimal point two places to the left. The general *rule* may be thus expressed:

RULE.—The reciprocal of the rate is the time for which the interest on any sum of money will be shown by simply removing the decimal point two places to the left; for ten times that time, remove the point one place to the left; for $\frac{1}{10}$ of the same time, remove the point three places to the left.

Increase or diminish the results to suit the time given.

NOTE.—The reciprocal of the rate is found by *inverting* the rate; thus 3 per cent. per month, inverted, becomes $\frac{1}{3}$ of a month, or 10 days.

When the rate is expressed by one figure, always write it thus, $\frac{3}{1}$, three ones.

EXAMPLE.—What is the interest on $125.00 for 10 days, at 3% per month? Ans. $1.25.

Process—rate 3%.

$\frac{3}{1}$ inverted becomes $\frac{1}{3}$ of a month, which is 10 days; by inverting the rate, we have found that in *ten days* a dollar earns a cent at 3% per month;

1 cent is the $\frac{1}{100}$ part of a dollar; the interest for that time will be found by simply removing the decimal point two places to the left, because removing the point two places to the left divides by 100.

2. What is the interest for 100 days on 276.00 dollars, at 3% per month? Ans. \$27.60

Process—$\frac{3}{1}$ inverted becomes $\frac{1}{3}$ of a month, or 10 days, the time in which a dollar earns a cent at 3% per month; 10 times 10 days is 100 days; in 100 days a dollar earns 10 cents, and the interest for that time will be found by removing the point one place to the left, because removing the point one place to the left divides by 10.

Example 3.—What is the interest for 1 day, at 3 per cent. per month, on 115 dollars.

Ans. 11 cents and 5 mills.

Process—$\frac{3}{1}$ inverted becomes $\frac{1}{3}$ of a month, or 10 days, the time in which a dollar earns a cent at 3% per month; $\frac{1}{10}$ of 10 days is 1 day, then in 1 day a dollar earns $\frac{1}{10}$ of a cent; $\frac{1}{10}$ of a cent is a mill, a mill is $\frac{1}{1000}$ of a dollar; the interest for 1 day at 3% per month, will be found by removing the decimal point three places to the left, because removing the point three places to the left divides any sum by 1000.

**Note.**—Removing the decimal point one place to the left divides any sum by 10, and will always show the interest for the time it takes a dollar to earn ten cents, no matter what the rate per cent. may be.

Removing the decimal point two places to the left divides any sum by 100 and will always show the interest for the time it takes a dollar to earn 1 cent, no matter what the rate per cent.

Removing the decimal point 3 places to the left divides any sum by 1000, and will always show the interest for the time it takes a dollar to earn a mill, no matter what the rate per cent.

Inverting the rate will always indicate the time it takes a dollar to earn a cent, at any rate per cent.; ten times that time is the time in which a dollar earns ten cents; one tenth of the same time is the time in which a dollar earns a mill.

In actual business a month is equivalent to 30 days, a year to 360 days.

4. What is the interest for 45 days on $227.50 at 2% per cent. per month? Ans. 6.825.

Process—$\frac{2}{1}$ inverted is $\frac{1}{2}$ a month, 15 days; the interest for 15 days, $2.275 \times 3 = 6.825$.

Find the interest on all the following sums at 9% per annum for 4 days, 40 days, and 400 days.

| Interest for 4 days. | Interest for 40 days. | Interest for 400 days. | |
|---|---|---|---|
| $2 | 2 | 4 | 6.90 |
| 1 | 7 | 2 | 1.19 |
| 5 | 9 | 7 | 3.21 |
| 6 | 4 | 1 | 9.75 |
| 4 | 5 | 6 | 3.28 |
| 0 | 0 | 1 | 8.19 |

The interest in the first example, for four days, is to be read: 2 dollars, 24 cents, 6 mills, and $\frac{9}{10}$ of a mill. The interest for 400 days on all, is found by simply striking a line one place to the left, the *line* standing for the *decimal point;* read off the dollars on the left of the line; the cents and the mills on the right.

*To find the interest for* 40 *days, draw the line* 2 *places to the left.*

*To find the interest for* 4 *days, draw the line* 3 *places to the left.*

We find the time, 4, 40, and 400 days, thus: $\frac{9}{1}$ inverted is $\frac{1}{9}$, of a year, or 40 days, the time in which a dollar earns a cent at 9% per annum; 10 times 40 days are 400 days, the time in which a dollar earns 10 cents; and $\frac{1}{10}$ of 40 days is 4 days, the time in which a dollar earns $\frac{1}{10}$ of a cent—a mill, or $\frac{1}{1000}$ of a dollar—at the same rate.

It is obvious that if by the preceding simple operation we calculate the interest on *all* those examples *at once*, if a million examples were written in an even perpendicular column, the interest on the million examples can be calculated by this rule as quickly as the interest on one example.

6. Find the interest for 24 days, and for 8 months at $1\frac{1}{4}$% per month, on $746.85.

Ans. Interest for 24 days, $7.4685.
Interest for 8 months, $74.685.

Process—$1\frac{1}{4} = \frac{5}{4}$, inverted is $\frac{4}{5}$, of a month = 24 days, the time it takes a dollar to earn a cent at $1\frac{1}{4}\%$. The interest for that time is found by removing the point 2 places to the left.

24 days × 10 = 240 days, or 8 months, the time in which a dollar earns 10 cents at $1\frac{1}{4}\%$. The interest for that time is found by removing the point one place to the left.

We append a few

### EXAMPLES IN INTEREST.

We leave the learner to supply others as he becomes familiar with the rule.

7. Find the interest for \$175 for 45 days at 8% per annum. Ans. \$1.75.

8. Find the interest for $4\frac{1}{2}$ days on \$227, at 8% per annum. Ans. \$.227.

9. Find the interest for 15 months at 8% per annum on \$975. Ans. \$97.50.

10. Find the interest on \$288 for 9 days at $3\frac{1}{3}\%$ per month. Ans. \$2.88.

11. Find the interest on \$745.50 for 3 months, at $3\frac{1}{3}\%$ per month. Ans. \$74.55.

12. Find the interest for 3 days, at 1% per month, on \$1000. Ans. \$1.

13. Find the interest on \$963 for 2 days, at $1\frac{1}{2}\%$ per month. Ans. \$.963.

14. Find the interest on \$749 for 20 days, $1\frac{1}{2}\%$ per month. Ans. \$7.49.

15. Find the interest for 200 days on $295, at 1½% per month. Ans. 29.50.

16. Find the interest on $286 for 12 days, at 2½% per month. Ans. $2.86

17. Find the interest on $740 for 4 months, at 2½% per month. Ans. $74.

18. Find the interest on $890 for 3 months, at 4% per annum. Ans. $8.90.

19. Find the interest for 9 days on $755, at 4% per annum. Ans. 75½ cents.

20. Find the interest for 72 days on $973, at 5% per annum. Ans. $9.73.

21. Find the interest for 6 days on 7495 dollars, at 6% per annum. Ans. $7.495.

22. Find the interest for 36 days on 550 dollars, at 10% per annum. Ans. $5.50.

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## BRITISH MONEY.

Howard's new method of computing interest may be used for computing interest on British money by observing the following:

Rule.—Reduce shillings, pence and farthings to decimals of a pound, and proceed as with dollars and cents; having found the answer, reduce back to pounds, shillings, &c.

NOTE.—By carefully observing and practicing the following instructions, the converting of shillings, pence and farthings into decimals of a pound, and *vice versa*, will become a purely mental and instantaneous operation.

1. For every two shillings, or florin, write .1, because two shillings is $\frac{1}{10}$ of a pound stg.

2. For every 1 shilling, write .05, because one shilling is $\frac{5}{10}$ of a florin, or $\frac{5}{100}$ of a pound stg.

3. For every six-pence, write .025, because sixpence is $\frac{25}{100}$ of a florin, or $\frac{25}{1000}$ of a pound stg.

4. For every $2\frac{1}{2}$ pence, write .01, because $2\frac{1}{2}$ pence is $\frac{1}{100}$ of a pound stg.

5. For every farthing, write .001, because a farthing is $\frac{1}{1000}$ of a pound stg.

| | | | |
|---|---|---|---|
| £19,,2 | written decimally | becomes | 19.1 |
| 19,,3 | " | " | 19.15 |
| 19,,4 | " | " | 19.2 |
| 19,,5 | " | " | 19.25 |
| 19,,18 | " | " | 19.9 |
| 19,,19 | " | " | 19.95 |
| 19,,19,,$2\frac{1}{2}$ | " | " | 19.96 |
| 19,,19,,5 | " | " | 19.97 |
| 27,,12,,6 | " | " | 27.625 |
| 19,,19,,$5\frac{1}{4}$ | " | " | 19.971 |
| 19,,18,,$0\frac{3}{4}$ | " | " | 19.903 |
| 19,,16,,$1\frac{3}{4}$ | " | " | 19.807 |
| 24,, 1,,$1\frac{1}{2}$ | " | " | 24.056 |

The learner may extend the exercises indefinitely. the *essentials* to remember are—

1st. Each unit of the first figure to the right of the decimal stands for *two* shillings.

2d. Each 5 in the second figure to the right of the decimal, stands for *one* shilling.

3d. Each unit *above* or *below* 5 in the second figure, stands for $2\frac{1}{2}$ pence.

4th. Each unit of the third figure to the right of the decimal, stands for 1 farthing.

5th. Each unit of the fourth figure to the right of the decimal, stands for $\frac{1}{10}$ of a farthing.

NOTE.—The *exact* value of each unit in the second figure to the right of the decimal is $2\frac{4}{10}$ of a penny, and of each unit in the third figure to the right of the decimal, $\frac{24}{100}$ of a penny, the difference of the assumed and the real value is too trifling to affect any actual business operation. The *florins*, *shillings* and *sixpences* are decimally expressed *absolutely* correct.

NOTE.—Howard's new rule for computing interest is in every way applicable to British money, the learner taking care to read *pounds* and *hundredths* in the place of *dollars* and *cents*.

1. Find the interest on £125 for 10 days, at 3% per month. Ans. £1,,5,,0.

Process—Simply remove the decimal point two places to the left, thus: 1.25, 1 pound and $\frac{25}{100}$ of a pound, or 1 pound, 5 shillings.

We invert the rate to find the time in which any unit of value—in this case 1 pound sterling—

will earn the $\frac{1}{100}$ part of itself at any rate per cent. The rate is 3 per cent.; $\frac{3}{1}$, inverted is $\frac{1}{3}$, of a month = 10 days. We find that in ten days a pound sterling will earn the $\frac{1}{100}$ part of itself, at 3 per cent. per month, and the interest for that time will always be found by removing the decimal point two places to the left. In 10 times the time indicated, or 100 days, the pound sterling will earn $\frac{1}{10}$ of itself at the same rate, and the interest for 100 days will be found by removing the decimal point one place to the left, because removing the point 1 place divides by 10, so the interest on £125 for 100 days at 3% per month, £12.5 = £12,,10,,0. In $\frac{1}{10}$ of the time indicated, in this case 1 day, the pound sterling will earn $\frac{1}{1000}$ part of itself at 3% per month, the interest for one day will be found by removing the point 3 places to the left, because removing the point three places divides by 1000, the interest for 1 day on £12.5 is .125 = £0,,2,,6.

1. Find the interest on 123 pounds sterling for 5 months, at 2% per month. £12,,6,,0.

Simply remove the decimal point one place to the left, 12.3, $12\frac{3}{10}$ pounds, or £12,,6; *find the time by inverting the rate.*

2. Find the interest for 15 days on 123 pounds sterling, at 2% per month. Ans. £1 ,, 4 ,, $7\frac{1}{2}$.

Remove the point 2 places to the left; 1.23 = £1 ,, 4 ,, $7\frac{1}{2}$.

3. Find the interest on £129 for 40 days, at $\frac{3}{4}$ of 1% per month. Ans. £1 ,, 5 ,, 10.

4. Find the interest on £272 „ 6s. 0d. for 3 days, at 1% per month. Ans. £0 „ 5 „ 5½.

5. Find the interest on £1726 „ 16s. for 72 days, at 5% per annum. Ans. £17.268 = £17 „ 5 „ 2½.

6. Find the interest on £748 „ 18s. for 45 days, at ⅔ of 1% per month. Ans. £7.489 = £7 „ 9 „ 9¾.

7. Find the interest on £698 „ 13s. for 2 months, at 6% per annum. Ans. £6.9865 = £6 „ 19 „ 9⅛.

8. Find the interest on £65 „ 18 „ 6 for 2½ yrs., at 4% per annum. Ans. £6.5975 = £6 „ 12 „ 1.

The learner can supply other examples.

The British people would simplify all their monetary operations, and save millions every year in labor alone, by adopting the decimal system of coinage. The cost and temporary inconvenience incident to the change would be trifling, almost *nil*, in view of the advantage to be gained. The pound, the florin, the shilling and the sixpence might be retained. Make the smallest coin, the farthing, equal to the $\frac{1}{1000}$ of a pound, and the thing is done.

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# COMPOUND INTEREST.

The rule for calculating compound interest, is to add the interest to the principal, and calculate the interest on the sum. The use of the following table will shorten this tedious process. It gives

the amount for one dollar at 5, 6 and 7 per cent. for from 1 to 20 years. Multiply the amount for $1 by the given number of dollars, and the product is the answer.

**Table,**

Showing the amount of $1 at compound interest for any number of years, not exceeding twenty:

| YEARS. | 5 PER CENT. | 6 PER CENT. | 7 PER CENT. |
|---|---|---|---|
| 1 | 1.050000 | 1.060000 | 1.070000 |
| 2 | 1.102500 | 1.123600 | 1.144900 |
| 3 | 1.157625 | 1.191016 | 1.225043 |
| 4 | 1.215506 | 1.262477 | 1.310796 |
| 5 | 1.276282 | 1.338226 | 1.402552 |
| 6 | 1.340096 | 1.418519 | 1.500730 |
| 7 | 1.407100 | 1.503630 | 1.605781 |
| 8 | 1.477455 | 1.593848 | 1.718186 |
| 9 | 1.551328 | 1.689479 | 1.838459 |
| 10 | 1.628895 | 1.790848 | 1.967151 |
| 11 | 1.710339 | 1.898299 | 2.104852 |
| 12 | 1.795856 | 2.012196 | 2.252192 |
| 13 | 1.885649 | 2.132928 | 2.409845 |
| 14 | 1.979932 | 2.260904 | 2.578534 |
| 15 | 2.078928 | 2.396558 | 2.759032 |
| 16 | 2.182875 | 2.540352 | 2.952164 |
| 17 | 2.292018 | 2.692773 | 3.158815 |
| 18 | 2.406619 | 2.854339 | 3.379932 |
| 19 | 2.526950 | 3.025600 | 3.616526 |
| 20 | 2.653298 | 3.207135 | 3.869684 |

NOTE.—The above table is available for British money by reading pounds and decimals of a pound, for dollars and decimals of dollars.

To find the time in which any sum will double itself at compound interest, at any rate not exceeding 10% per annum.

Rule.—Divide 70 by the rate of interest, and take the whole number nearest the quotient. This is the number of years.

| Rate. | | Years. |
|---|---|---|
| 3 | $\frac{70}{3}$ = | 23 |
| 4 | $\frac{70}{4}$ = | 17 |
| 5 | $\frac{70}{5}$ = | 14 |
| 6 | $\frac{70}{6}$ = | 12 |
| 7 | $\frac{70}{7}$ = | 10 |
| 8 | $\frac{70}{8}$ = | 9 |
| 9 | $\frac{70}{9}$ = | 8 |
| 10 | $\frac{70}{10}$ = | 7 |

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# DISCOUNT.

Discount, being of the same nature as interest, is, strictly speaking, the use of money before it is due. The term is also applied to a deduction of so much per cent. from the face of a bill, or the deducting of interest from the face of a note before any interest has accrued. Banks generally include

in their reckoning both the day when the note is discounted and the day on which the time specified in it expires, which, with three days of grace, makes the time for which discount is taken four days more than the time specified in the note. *True Discount* differs from *Bank Discount*, that is, the true discount on a debt of 109 dollars due a year hence would be 9 dollars, the legal interest being at the rate of 9 per cent., and the present worth of the note is 100 dollars.

In calculating interest the sum on which interest is to be paid is known, but in computing discount we have to find what sum must be placed at interest, so that the sum, together with its interest, will amount to the given principal; the sum thus found is called the "Present worth."

*To find the present worth of any sum, and the discount for any time at any rate per cent.*

RULE.—Divide the given sum by the amount of $1 for the given time and rate, and the quotient will be the present worth, and the remainder will be the discount.

EXAMPLE 1.—Find the present worth of a note for 228 dollars, due 2 years from date at 7 per cent.

Ans. $200.

2. Find the bank discount on a note for $1200, due 60 days from date.

60 + 4 = 64 days time for which discount must be reckoned. $\frac{1}{6}$ of 64 = $10\frac{2}{3} \times 1200 = 12.800$.

$Ans. 12.80.

Merchants are in the habit of deducting a certain percentage from invoices of goods sold. This is reckoned in the same manner as interest.

A bill of goods is bought, amounting to 960 dollars at a year's credit, the merchant offers to deduct 10% for ready cash, what amount is to be deducted?

9.60 × 10 = $96.00, Ans.

By discounting the face of bills, a loss may be sustained without suspecting it; this arises from the fact that the discount is not only made on the first cost of the goods, but also on the profits; for instance, if a profit of 30% be made on any article of merchandise, and the 10% be deducted, the gain at first sight would appear to be 20%, but is in reality only 17%. If a profit of 60% be added to the first cost, and then a discount made of 45%, the apparent profit would be 15%; instead of this, an actual loss is made of 12%, as will be seen by the following examples:

| Example 1. | | Example 2. | |
|---|---|---|---|
| Cost of goods, | $100 | Cost, | $100 |
| Add 30% profit, | 30 | Profit 60%, | 60 |
| Selling price, | 130 | Selling price, | 160 |
| Deduct 10% discount, | 13 | Discount 45%, | 72 |
| Cash price, | $117 | Cash price, | $88 |
| Gain 17%. | | Loss 12%. | |

# STOCKS AND BONDS.

Stocks and bonds are quoted in New York by so much on the hundred, premium or discount; in Philadelphia at their actual price. That is, if the par value of a stock is $50, and it is 6% above par, the New York quotation would be 106, the Philadelphia quotation 53.

When the premium is known, the par value plus the premium equals the market value. When at a discount, the par value minus the discount equals the market value.

*To find to what rate of interest a given dividend corresponds.*

Rule.—Divide the rate per unit of dividend by 1 plus or minus the rate per cent., premium or discount, according as the stocks are above or below par.

*To find at what price stock paying a given rate per cent. dividend can be purchased, so that the money invested shall produce a given rate of interest.*

Rule.—Divide the rate per unit of dividend by the rate per unit of interest.

**EXCHANGE made easy by Howard's New Table of Reciprocals, car-**
**Promisory Notes, &c. Also the relative values of Gold and Curren-**

| *Gold.* | *Currency.* | *Pound Stg.* | *Value of Dollar British Money.* |
|---|---|---|---|
| 100 | 100 | 4.866500000 | .2054864892 |
| 100⅛ | .9987515645 | 4.872583125 | .2052299518 |
| 100¼ | .9957062344 | 4.878666250 | .2049740541 |
| 100⅜ | .9962640099 | 4.884749375 | .2047187937 |
| 100½ | .9950248756 | 4.890832500 | .2044641684 |
| 100⅝ | .9937888198 | 4.896915625 | .2042101756 |
| 100¾ | .9925558312 | 4.902998750 | .2039568131 |
| 100⅞ | .9913258984 | 4.909081875 | .2037040785 |
| 101 | .9900990099 | 4.915165000 | .2034519695 |
| 101⅛ | .9888751545 | 4.921248125 | .2032004838 |
| 101¼ | .9876543209 | 4.927331250 | .2029496190 |
| 101⅜ | .9864364981 | 4.933414375 | .2026993728 |
| 101½ | .9852216748 | 4.939497500 | .2024497431 |
| 101⅝ | .9840098400 | 4.945580625 | .2022007274 |
| 101¾ | .9828009828 | 4.951663750 | .2019523236 |
| 101⅞ | .9815950920 | 4.957746875 | .2017045293 |
| 102 | .9803921568 | 4.963830000 | .2014573424 |
| 102⅛ | .9791921664 | 4.969913125 | .2012107606 |
| 102¼ | .9779951100 | 4.975996250 | .2009647817 |
| 102⅜ | .9768009768 | 4.982079375 | .2007194034 |
| 102½ | .9756097560 | 4.988162500 | .2004746237 |
| 102⅝ | .9744214372 | 4.994245625 | .2002304402 |
| 102¾ | .9732360097 | 5.000328750 | .1999868508 |
| 102⅞ | .9720534629 | 5.006411875 | .1997438534 |
| 103 | .9708737864 | 5.012495000 | .1995014458 |
| 103⅛ | .9696969696 | 5.018578125 | .1992596259 |
| 103¼ | .9685230024 | 5.024661250 | .1990183915 |
| 103⅜ | .9673518742 | 5.030744375 | .1987777405 |
| 103½ | .9661835749 | 5.036827500 | .1985376778 |
| 103⅝ | .9650180941 | 5.042910625 | .1982981802 |
| 103¾ | .9638554216 | 5.048993750 | .1980592667 |
| 103⅞ | .9626955475 | 5.055076875 | .1978209318 |
| 104 | .9615384615 | 5.061160000 | .1975831627 |
| 104⅛ | .9603841537 | 5.067243125 | .1973459688 |
| 104¼ | .9592326139 | 5.073326250 | .1971093422 |
| 104⅜ | .9580838323 | 5.079409375 | .1968732831 |
| 104½ | .9569377990 | 5.085492500 | .1966377888 |
| 104⅝ | .9557945042 | 5.091515625 | .1964051716 |
| 104¾ | .9546539379 | 5.097658750 | .1961684861 |
| 104⅞ | .9535160906 | 5.103741875 | .1959346739 |
| 105 | .9523809523 | 5.109825000 | .1957014183 |

ried out to ten decimals, Showing the net value of Bills of Exchange cy in American and British money, with Gold at any price

| Gold. | Currency. | Pound St'g. | Value of Dollar British Money. |
|---|---|---|---|
| 105⅛ | ——.9512485136 | ——5.115908125 | ——.1954687175 |
| 105¼ | ——.9501187648 | ——5.121991250 | ——.1952365693 |
| 105⅜ | ——.9489916963 | ——5.128074375 | ——.1950049720 |
| 105½ | ——.9478672985 | ——5.134157500 | ——.1947739234 |
| 105⅝ | ——.9467455622 | ——5.140240625 | ——.1945434218 |
| 105¾ | ——.9456264775 | ——5.146323750 | ——.1943134650 |
| 105⅞ | ——.9445100354 | ——5.152406875 | ——.1940840512 |
| 106 | ——.9433962264 | ——5.158490000 | ——.1938551785 |
| 106⅛ | ——.9422850412 | ——5.164573125 | ——.1936268456 |
| 106¼ | ——.9411764705 | ——5.170656250 | ——.1933990487 |
| 106⅜ | ——.9400705052 | ——5.176739375 | ——.1931717877 |
| 106½ | ——.9389671361 | ——5.182822500 | ——.1929450603 |
| 106⅝ | ——.9378663540 | ——5.188905625 | ——.1927188645 |
| 106¾ | ——.9367681498 | ——5.194988750 | ——.1924931983 |
| 106⅞ | ——.9356725146 | ——5.201071875 | ——.1922680601 |
| 107 | ——.9345794392 | ——5.207155000 | ——.1920434479 |
| 107⅛ | ——.9334889148 | ——5.213238125 | ——.1918193598 |
| 107¼ | ——.9324009324 | ——5.219321250 | ——.1915957941 |
| 107⅜ | ——.9313154831 | ——5.225404375 | ——.1913727492 |
| 107½ | ——.9302325581 | ——5.231487500 | ——.1911502225 |
| 107⅝ | ——.9291521486 | ——5.237570625 | ——.1909282132 |
| 107¾ | ——.9280742459 | ——5.243653750 | ——.1907067185 |
| 107⅞ | ——.9269988412 | ——5.249736875 | ——.1904857374 |
| 108 | ——.9259259259 | ——5.255820000 | ——.1902652678 |
| 108⅛ | ——.9248554913 | ——5.261903125 | ——.1900453079 |
| 108¼ | ——.9237875288 | ——5.267986250 | ——.1898258561 |
| 108⅜ | ——.9227220299 | ——5.274069375 | ——.1896069105 |
| 108½ | ——.9216589861 | ——5.280152500 | ——.1893884693 |
| 108⅝ | ——.9205983889 | ——5.286235625 | ——.1891705309 |
| 108¾ | ——.9195402299 | ——5.292318750 | ——.1889530935 |
| 108⅞ | ——.9184845006 | ——5.298401875 | ——.1887361554 |
| 109 | ——.9174311926 | ——5.304485000 | ——.1885197149 |
| 109⅛ | ——.9163802978 | ——5.310568125 | ——.1883037702 |
| 109¼ | ——.9153318077 | ——5.316651250 | ——.1880883197 |
| 109⅜ | ——.9142857142 | ——5.322734375 | ——.1878733616 |
| 109½ | ——.9132420091 | ——5.328817500 | ——.1876588943 |
| 109⅝ | ——.9122006841 | ——5.334900625 | ——.1874449160 |
| 109¾ | ——.9111617312 | ——5.340983750 | ——.1872314253 |
| 109⅞ | ——.9101251422 | ——5.347066875 | ——.1870184202 |
| 110 | ——.9090909090 | ——5.353150000 | ——.1868059180 |

## PARTIAL PAYMENTS.

RULE.—Find the total amount of principal and interest for the whole time to the day of settlement; compute the interest on the several payments, from the time each was paid to the day of settlement; add the several payments and the interest on each together, and subtract the sum from the total amount, and the difference will be the sum due.

EXAMPLE.—Smith gave Jones his note for $5000. dated January 1st, 1873. Interest 6%.

| | | | | |
|---|---|---|---|---|
| March 1st, | Smith | paid | Jones | $100. |
| April 1st, | " | " | " | 250. |
| July 1st, | " | " | " | 1200. |

How much was due to Jones January 1st, 1874?

Ans. $3697.75.

| | | |
|---|---|---|
| Process— Principal, | | $5000.00 |
| Interest for one year, | | 300.00 |
| Total, | | $5300.00 |
| 1st payment (March 1st), | $ 100.00 | |
| Interest to Jan. 1st. 1874, | 5.00 | |
| 2d payment, (April 1st), | 250.00 | |
| Interest to Jan. 1st, 1874, | 11.25 | |
| 3d payment (July 1st), | 1200.00 | |
| Interest to Jan. 1st, 1874, | 36.00 | |
| | | 1602.25 |
| | | $3697.75 |

# SQUARE AND CUBE ROOT.

The first essential for the learner is to make himself familiar with the following properties of numbers:

1. A square number multiplied by a square number, the product will be a square number.

2. A square nnmber divided by a square number, the quotient is a square.

3. A cube number multiplied by a cube, the product is a cube.

4. A cube number divided by a cube, the quotient will be a cube.

5. If the square root of a number is a composite number, the square itself may be divided into integer square factors; but if the root is a prime number, the square cannot be separated into square factors without fractions.

6. If the unit figure of a square number is 5, we may multiply by the square number 4, and we shall have another square, whose unit period will be ciphers.

7. If the unit figure of a cube is 5, we may multiply by the cube number 8, and produce another cube, whose unit period will be ciphers.

8. If a supposed cube, whose unit figure is 5, be multiplied by 8, and the product does not give 3 ciphers on the right, the number is not a cube.

TABLE

For comparing the natural numbers with the unit figure of their squares and cubes. By the use of this, many roots may be extracted by observation:

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Numbers... | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Squares.... | 1 | 4 | 9 | 16 | 25 | 36 | 49 | 64 | 81 | 100 |
| Cubes...... | 1 | 8 | 27 | 64 | 125 | 216 | 343 | 512 | 729 | 1000 |

The product of a number taken any number of times as a factor, is called a power of the number.

A root of a number is such a number as taken some number of times as a factor, will produce a given number.

If the root is taken twice as a factor to produce the number, it is the *square root;* if three times, the *cube root;* if four times, the *fourth root.*

By observing the above table, it will be seen that the square of any one of the digits is less than 100, and the cube of any one of the digits is less than 1000; therefore, the square root of two figures cannot be more than one figure.

If we begin at the right of any number and separate it into periods of two figures each, the number of periods would be the same as the number of figures in its square root.

1. Find the square root of 81. Ans. 9.
2. Find the square root of 49. Ans. 7.
3. Find the square root of 625. Ans. 25.

If the root is an integer number, we know by the inspection of the table that it must be 25, as the greatest square in 6 is two, and 5 is the only figure whose square is five in the unit's place.

4. Find the square root of 6561. Ans. 81.

As the unit figure in this example is 1, and in the line of squares in the table, we find 1, only at 1 and 81; we therefore divide 6561 by 81, and we find the quotient 81; 81 is therefore the square root.

5. Find the square root of 106929. Ans. 327.

As the unit figure in this example is 9, it the number is a square, it must divide by either 9 or 49. After dividing by 9, we have 11881 for the other factor, a prime number, therefore its root is a prime number, = 109; 109 × 3, the root of 9, gives 327, the answer.

6. Find the square root of 451584. Ans. 672.

As the unit figure is 4, and in the table we find 4 only at 4 and 64, the number, if a square, must divide by 4 or 64, or by both.

We divide it by 4, and we have the factors 4 and 112896. The unit figure of this last factor is 6, therefore by looking at the table, we see it must divide by 16 or 36, etc.

We divide by 36, and we have the factors 36 and 3136; divide this last by 16, and we have 16 and 196; divide this last factor by 4 and we have 4 and 49.

Take now our divisors and last factor 49, and we have for the original number, the product of 4 × 36 × 16 × 4 × 49, the roots of which are 2 × 6 × 4 × 2 × 7 the products of which are 672, the answer.

7. Find the square root of 2025. Ans. 45,

Divide by the square number 25, and we find the two factors 25 × 81, the given number, roots of these factors, 5 × 9 = 45; or multiply by the square number 4, when a number ends in 25, and we have 8100, root 90; half of which, because we multiplied by 4, the square of 2, is 45.

The square root of a number may also be found by removing the decimal point two places, extract the square root of the quotient, and we have $\frac{1}{10}$ of the root of the number.

### METHOD OF EXTRACTING CUBE ROOT.

By observing the *table*, we see that the entire part of the cube root of any number below 1000, will be less than 10, and will contain but 1 figure. The entire part of the cube root of a number containing four, five and six figures, will contain two figures, and so on with the larger numbers.

| | |
|---|---|
| 10000 | 1953125 (100 + 20 + 5 |
| ——— | 1000000 |
| 30000 | |
| 6000 | ——— |
| 400 | 953125 |
| ——— | 728000 |
| 36400 | ——— |
| 6000 | 225125 |
| 800 | 225125 |
| ——— | ——— |
| 43200 | |
| 1800 | |
| 25 | |
| ——— | |
| 45025 | |

## To Extract Cube Root.

Add to each true divisor, as they occur, twice the surface of one side of the small cube, and one of each of the three parallelopipedons, for a trial divisor; because that will make three sides of the complete cube.

By observation the reason is evident, and the conclusion just, for making trial and true divisors by this method.

We have an infinite number of ways of finding the square root, cube root, etc. Presume the root to be divided into a certain number of parts. Square the parts in square root; cube them in cube root to find the divisor. Thus let $a + a$ represent the square root of any number. The square of $a + a$ is $4a^2$; hence, divide any number by 4 and extract the square root of the quotient, and we have half of the root. Divide any number by the square of 3, and extract the square root of the quotient, and we have one-third of the root, etc., for all numbers. In the cube root we cube the number representing the parts the root is divided into, for a divisor.

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# MISCELLANEOUS.

1. Jay Gould had ninety rabbits; he also had three sons, named Jim Fisk, Emperor Norton, and

Boss Tweed; to Jim Fisk he gave 10 rabbits, to Emperor Norton he gave 30 rabbits, and to Boss Tweed he gave the remainder; they each sold their rabbits at the same rates, and when all were sold they each had the same amount of money; state how this result was arrived at.

| | |
|---|---|
| Jim Fisk sold 7 at the rate of 7 for \$1 = | \$1.00 |
| " " 3 " " 1 for \$3 = | 9.00 |
| | \$10.00 |
| Norton sold 28 at the rate of 7 for \$1 = | 4.00 |
| " " 2 at the rate of 1 for \$3 = | 6.00 |
| | \$10.00 |
| Boss Tweed sold 49 at the rate of 7 for \$1 = | 7.00 |
| " " 1 " " 1 " 3 = | 3.00 |
| | \$10.00 |

2. Divide \$60 amongst 3 persons in the proportion of $\frac{1}{3}$ to A, $\frac{1}{4}$ to B, and $\frac{1}{5}$ to C.

| | |
|---|---|
| $60 \times \frac{1}{3} = 20$ | $\frac{60}{47} \times 20 = \$25\frac{25}{47}$, share of A. |
| $60 \times \frac{1}{4} = 15$ | $\frac{60}{47} \times 15 = \$19\frac{7}{47}$, " " B, |
| $60 \times \frac{1}{5} = 12$ | $\frac{60}{47} \times 12 = \$15\frac{15}{47}$, " " C, |
| 47 | \$60 Total. |

3. If 7 cats can kill 7 rats in 7 minutes, how many cats will be required to kill 100 rats in 50 minutes?

$$\frac{\cancel{7} \times 7 \times \overset{2}{\cancel{100}}}{\cancel{7} \qquad \cancel{50}} = 14. \quad \text{14 cats, Ans.}$$

### Gaugers' Work.

*To find the contents of a cask in gallons.*

RULE.—Add two-thirds the difference of the head and bung diameters to the head diameter, to find the mean diameter; then multiply the product of the square of the mean diameter into the length by .0034.

NOTE.—If the staves are but little curved, add six-tenths instead of two-thirds.

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## GENERAL INFORMATION.

The circumference of a circle equals the diameter multiplied by 3.1416, the ratio of the circumference to the diameter.

The area of a circle equals the square of the radius multiplied by 3.1416.

The area of a circle equals one quarter of the diameter multiplied by the circumference.

The radius of a circle equals the circumference multiplied by 0.159155.

The radius of a circle equals the square root of the area multiplied by 0.56419.

The diameter of a circle equals the circumference multiplied by 0.31831.

The diameter of a circle equals the square root of the area multipled by 1.12838.

The side of an inscribed equilateral triangle equals the diameter of the circle multiplied by 0.86.

The side of an inscribed square equals the diameter of a circle multiplied by 0.7071.

The side of an inscribed square equals the circumference of the circle multiplied by 0.225.

The circumference of a circle multiplied by 0.282 equals one side of a square of the same area.

The side of a square equals the diameter of a circle of the same area multiplied by 0.8862.

The area of a triangle equals the base multiplied by one-half its altitude.

The area of an ellipse equals the product of both diameters and .7854.

The solidity of a sphere equals its surface multiplied by one-sixth of its diameter.

The surface equals the product of the diameter and circumference.

The surface of a sphere equals the square of the diameter multiplied by 3.1416.

The surface equals the square of the circumference multiplied by 0.3183.

The solidity of a sphere equals the cube of the diameter multiplied by 0.5236.

The diameter of a sphere equals the square root of the surface multiplied by 0.56419.

The square root of the surface of a sphere multiplied by 1.772454 equals the circumference.

The diameter of a sphere equals the cube root of its solidity multiplied by 1.2407.

The circumference of a sphere equals the cube root of its solidity multiplied by 3.8978.

The side of an inscribed cube equals the radius multiplied by 1.1547.

The solidity of a cone or pyramid equals the area of its base multiplied by one-third of its altitude.

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Howard's new rule for computing interest, 365 days to the year, when the time for which interest is required is for any number of years:

RULE.—Remove the decimal point *two* places to the left, and multiply by the number of years and the rate per cent.

EXAMPLE.—What is the interest on $740 for three years at 6 per cent.?

$$\begin{array}{r} 7.40 \\ 3 \\ \hline 22.20 \\ 6 \\ \hline 133.20 \end{array}$$

Ans. $133.20.

What is the interest on £220 for two years at 4 per cent.?

$$\begin{array}{r} 2.20 \\ 2 \\ \hline 4.40 \\ 4 \\ \hline 17.60 \end{array}$$

Ans. £17 12*s*. 0*d*.

When the interest required is for any given number of days, it is usual to divide by 365, which in practice is found to be very cumbrous. I have directed my researches to substitute a simpler divisor, with the following result:—To multiply by $1\frac{3}{20}$ and divide by 42 is in effect the same as to divide 10 by 365, in practice is very much simpler and shorter, the actual difference to each unit of value being only the difference of $\frac{1680}{61320}$ and $\frac{1679}{61320}$ or $\frac{1}{61320}$, too trifling to affect any business transaction.

To multiply by $1\frac{3}{20}$ add $\frac{1}{10}$ and half of $\frac{1}{10}$ of any number to itself.

Example: Multiply 100 by $1\frac{3}{20}$.

$$\begin{array}{r} 100 \\ 10 \\ 5 \\ \hline 115 \end{array}$$

To compute interest for any number of days, 365 days to the year:

RULE.—Multiply the principal by $1\frac{3}{20}$, remove the point *three* places to the left, and the interest will be shown for the following number of days, and rates, to find the interest for any other time or rate, increase or diminish:—

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 42 | days at | 1 | per cent. | 7 | days at | 6 | per cent. |
| 21 | „ | 2 | „ | 6 | „ | 7 | „ |
| 14 | „ | 3 | „ | 4 | „ | $10\frac{1}{2}$ | „ |
| 12 | „ | $3\frac{1}{2}$ | „ | 3 | „ | 14 | „ |
| $10\frac{1}{2}$ | „ | 4 | „ | 2 | „ | 21 | „ |

Remove the point *two* places to the left, and the interest will be shown for

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 84 | days at | 5 | per cent. | 35 | days at | 12 | per cent. |
| 56 | „ | $7\frac{1}{2}$ | „ | 28 | „ | 15 | „ |
| 42 | „ | 10 | „ | | | | |